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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....233, 246
Construction of the Mississippi River Extension of the Chicago & Eastern Illinois R. R. (With full page plate and other illustrations) 234
Pumping Gas under 20 lbs. Pressure from Phoenixville to Rogersford, Pa 235
The Delwik-Fleischer Water-Gas Process (illustrated.) 236
Track Construction on the Central London Underground Electric Railway (illustrated.)..... 237
Proper Sizes of Pipe for Hot Air House Heating.... 238
Iron Removal from Ground, Water at Far Rockaway by Slow Sand Filtration. (With full-page plate and other illustrations) 238
An American Engineer's Pocket Book of 1834 and Early Works on Surveying 239
Failure of the Great Masonry Dam Across the Colorado River at Austin, Tex. (Illustrated.)..... 244
The Heavy-Traffic Motor Vehicle Trials at Liverpool, England. 246
Freight Locomotive; East Indian Ry. (Illustrated.). 247
A New Type of Hand Hole Covers (illustrated.).... 248
Book Reviews 248
EDITORIAL NOTES 240
Is Steel Embedded in Concrete Protected from Corrosion when below Water Level?—The Use of Concrete and Wood in Combination.—The Law's Delays in the Prosecution of O. M. Carter and the Savannah Harbor Contractors.—A $200,000 Appropriation for Surveys for the New York Barge Canal.
EDITORIAL:
Future Possibilities in Gas Manufacture and Distribution 241
LETTERS TO THE EDITOR 241, 244
The Power Multiplying Engine Co.—Repairing Steel Tapes.—Some Recent Experiences with Tile Floors.—Why Compensation Reservoirs in Lieu of Damages for Water Diversion are Permissible in Great Britain, but not in the United States.—Diagrams Showing Safe Load on Columns According to the New York Building Code (illustrated.)—Laying Out Transition Curves (illustrated.)—The Scherzer Rolling Lift Bridge over the Fort Point Channel, Boston, Mass.—Should Taxes be Included with Other Operating Expenses in Railway Accounting? Notes and Queries.

THE WASHINGTON MEMORIAL BRIDGE designs submitted by Messrs. L. L. Buck, Wm. H. Burr, Wm. R. Hutton and Geo. S. Morison, Mems. Am. Soc. C. E., the engineers invited by the Secretary of War to prepare designs, have been reported upon. The conditions of the competition were that the designs were to be paid for in the order of merit, as follows: No. 1, $1,200; No. 2, $1,100; No. 3, $1,000, and No. 4, $900. The awards are as follows: First, for Design No. 2 of Mr. Wm. H. Burr; second, for design No. 2 of Mr. Wm. R. Hutton; third, for design No. 1 of Mr. L. L. Buck, and fourth, for design No. 1 of Mr. Geo. S. Morison The design receiving the first award is for a single deck bridge 60 ft. wide and 3,400 ft. long, including approaches. The bridge proper consists of six 192-ft. masonry arch spans, and one 170-ft. steel bascule span flanked by monumental towers arching over the roadway. The six masonry arches are located three on each side of the draw span. The Washington approach consists of twenty 60-ft. masonry arch spans and the Arlington approach consists of fifteen 60-ft. masonry arch spans. The Government Board of Engineers recommend in their report that this plan be modified by making the lower chord of the bascule span arch-shaped and by substituting the handsomer towers of Mr. Burr's design No. 1 for those shown. The bridge is designed to cross the Potomac River between Washington and Arlington, and is to be made of a monumental character to commemorate the deeds of American soldiers and sailors.

THE CONVENTION HALL at Kansas City, Mo., which was described and illustrated in our issue of Nov. 2, 1899, was destroyed by fire on April 4. The building was of brick, with steel roof trusses, but all the interior fittings were of wood. It is supposed that plumbers started the fire accidentally by their furnace or by crossing some electric wires that were in their way. Steps were at once taken to order steel work for the reconstruction of the building, so as to have it ready in time for the Democratic convention on July 4. The loss is estimated at $235,000, with an insurance of $155,000. The fire spread to adjacent buildings and destroyed the Second Presbyterian church and its parsonage, and damaged the Lathrop school and the Williamson business block. The total loss is estimated at $395,000, the insurance on which amounts to $260,000. The convention hall was 314 x 198¼ ft., with seating capacity for 25,000 persons. Its walls were of brick and stone, supporting steel roof trusses covered with a sheathed tar and gravel roof. Mr. Frederick E. Hill, of Kansas City, was the architect, and the steel work was built by the Gillette-Herzog Mfg. Co., of Minneapolis, Minn. Ground was broken in June, 1898, and the building was opened Jan. 2, 1899.

A SECOND FIRE IN THE HORNE STORE, at Pittsburg, Pa., on April 7, damaged the building and stock to the extent of many thousands of dollars. The fire is of particular interest on account of the fireproof construction of the building and for the reason that the entire contents of the store and a considerable portion of the steel frame and its fireproofing were destroyed by fire on May 3, 1897. This fire and the damage done by it to the frame and fireproofing were fully described in Engineering News of May 20 and 27 and July 1 and 15, 1897. Briefly described, the building is 120 x 180 ft. in plan, and six stories high, with a large interior well for lighting extending from the floor to the roof. The frame consists of Z-bar columns, beams and girders protected by hard burned tile fireproofing. The floor arches were of porous terra cotta end construction. A representative of Engineering News, who examined the building after the second fire of April 7, sends the following preliminary report of its origin and effects:

The fire started in the rear of the fifth floor and was communicated to two adjacent floors before any water reached the building, notwithstanding the fact that there were three watchmen and two engineers in the building at the time. The fire had gained such headway that the Fire Department could only confine it to these floors. Practically everything below the fourth floor was uninjured by fire and no steel was injured below the sixth floor. About 10 or 15% of the soffits or lower surface of sixth-floor tiles had cracked off, leaving the hollow interior of the tile open into the fifth story, but none of the arches failed completely. The suspended ceiling of the sixth story was made of 2 x 2-in. tees spaced 12 ins., supporting expanded metal and plaster. About 50 ft. of the rear portion of this had fallen, which exposed the roof beams to the heat, they in turn falling and pulling in portions of the rear and side walls. The roof was generally 10-in. I-beams supporting 2 x 2-in. tees, spaced 18 ins. and carrying book tile. These beams seem to have had no protection against fire except the suspended ceiling. This ceiling did good work for a time, as shown in front portion of sixth story. The restaurant was located here, and as there were no openings to act as flues the heat did not get beyond the collapsing point of the metal and only the surface of the plaster is injured. About seven or eight of the sixth story columns are badly twisted and bent. The damage to all structural steel work will probably not exceed $5,000, and it is possible that had the roof received more attention there would have been no steel injured except the suspended ceiling.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Magenta, Tex., on the line of the Fort Worth & Denver City R. R., on April 5. A passenger train was ditched by a defect in the track caused by a wash-out. The entire train was burned, two persons were killed and five were seriously injured.

A NICARAGUAN RAILWAY, from Managua east to Rama, on the Bluefields River, is proposed by President Zelaya. He proposes to raise the capital necessary by ordering that, after May 1, 15% of all duties shall be paid in the new railway bonds. This order would require all merchants to purchase the bonds from the government; and they would be sold at 85% of the face value. The bonds will be received for customs at par and the merchant then makes a profit. Surveys were made for this railway some years ago, but no details are given of the route. Rama is at the head of navigation on the Bluefields River, and is 70 miles from the Carribean Sea.

THE MONTEVIDEO HARBOR WORKS are to cost $12,000,000 in gold and will be paid for in gold, the Uruguayan Government having already raised the money to pay for the first and second year's work. It is stated that bids are now being invited for the work, and that, other things being equal, American contractors will be given the preference. We are informed by the Brown Hoisting & Conveying Machine Co., of Cleveland, O., that a complete set of the plans and specifications is on file at their office and that they will be cheerfully shown to anyone who will call.

THE NEW CUNARD STEAMER "IVERNIA," which will soon sail for New York on her first voyage, is 600 ft. long, 64 ft. 9 ins. beam and 49 ft. 6 ins. depth to shelter deck. She has a gross tonnage of 13,800 tons, and a net tonnage of 8,913 tons. The "Ivernia" is to be both a passenger and cargo steamer, and is claimed to have the largest cargo capacity of any steamer afloat.

THE ATLANTIC TRANSPORT STEAMSHIP "MINNEAPOLIS" has arrived in New York direct from her builders, Harlan & Wolff, Belfast, Ireland. She is 650 ft. long, 65 ft. beam, 44 ft. deep, with a gross tonnage of 13,700 and a displacement of 26,000 tons. She carries a crew of 146 men and 250 first cabin passengers, with no second-class or steerage passengers.

THE NAVAL BILL reported by the Home Naval Committee on April 5 carries an appropriation of $61,219,916. It includes ships authorized costing $28,350,000, exclusive of armor and armament. The report, in discussing armor plate, says that the battleships "Maine," "Ohio" and "Missouri," now under construction, require 7,359 tons of armor; it recommends the best armor obtainable and fixes the cost at $545 per ton for Krupp armor, which tests have proven to have 25% greater efficiency than Harveyized plate. The report recommends the removal of the restriction to $300 per ton for the armor of the battleships "Georgia," "Pennsylvania" and "New Jersey" and the armored cruisers "West Virginia," "Nebraska" and "California." Under the head of public works the bill appropriates large sums to the various naval stations and dockyards, including $630,000 to the Algiers dry-dock, and $600,000 to four dry-docks under construction at Portsmouth, Boston, League Island and Mare Island; two new stone dry-docks are provided for, at New York and at Norfolk. The new Naval Academy items aggregate $671,000; for ordnance, $1,750,000 is appropriated; $2,000,000 is for equipping vessels; $100,000 for coaling stations in insular possessions and for surveys.

AN ICE-BREAKING STEAMER on Lake Baikal, in Siberia, made a trial trip of 80 miles on Dec. 16 through ice 31 ins. in thickness. The trip was made in 12 hours, and is said to have been wholly satisfactory.

THE DEAD SEA is soon to be traversed by a steamboat line. The first vessel has been purchased and will shortly begin running.

THE IMPORTS OF AMERICAN RAILS INTO JAPAN exceeds those of any other country. The English Foreign Office says that the consular district of Hiogo and Osaka reports that metals take the third place in the list of imports into Japan; and bar-iron, in this list, took the leading place in 1898, with 30,000 tons, valued at $875,000, as against 22,000 tons in 1897. Pig-iron showed a similar advance, with over 35,000 tons, valued at $400,000; and plate and sheet-iron rose from 1,000 tons in 1897 to 11,000 tons in 1898. The most marked decrease in European exports to Japan was in steel rails, of which hardly 3,200 tons were taken, valued at $90,000, or two-thirds only of the exports of 1897. This decrease is due to the import of American rails, which were unknown in Japan until 1896. During the last three years the average import of rails into all Japan has been valued at over $1,250,000, half of which went to Hiogo. In 1896 American rails formed one-sixth of the total import; in 1897 they made one-third, and in 1898 more than one-half; and the British share in this trade fell from $1,000,000, in 1896, to $400,000 in 1898. Belgian rails fell from $145,000 to about one-quarter of that in the same period; and German rails from $55,000 to $65,000 in value. Lately, for 8,000 tons of rails to be delivered at Kobe, Carnegie underbid the English offer $3.24 per ton.

THE RAILWAYS OF RUSSIA now practically run from the White to the Black Sea on the one hand, and from the Baltic to the Yellow Sea on the other. In 1889 there were 28,490 versts (a verst being 0.667 mile), including 1,032 versts building. In 1899 there were 55,286 versts, including 10,910 building. The increase during the one year 1899 was 4,085 versts, as against an increase of 2,877 versts in 1898. The various totals on Jan. 1, 1900, were as follows:

	Versts.
Main lines of general importance—	
In European Russia	38,408
In Asiatic Russia	5,222
Local lines	746
Finnish lines	2,537
Lines open for temporary traffic	2,339
Length of actual railway system on Jan. 1, 1900..	49,252
Lines now building	9,050
" officially authorized, but not yet begun....	2,283

Thus, we have an actual total of 49,252 versts of lines open for traffic on Jan. 1, 1900, and a grand total of 60,585 versts under the three headings: open for traffic, building, and authorized. These figures are reported by Mr. Henry Cooke, the British Commercial Agent to Russia, who has the following information to give regarding the work of 1899: The first work in importance in 1899 is, of course, the Great Siberian Line, which may now be said to be nearing its conclusion, though large portions of the road completed have to be reballasted and relaid, numbers of bridges have to be reconstructed, etc. This led to an additional sum of 83,000,000 roubles being assigned last year for these purposes, attributed to the unforeseen increase of goods traffic on the line. Its value has been greatly enhanced since the Chinese Government leased the Quan Tung Peninsula to Russia, thus opening a more direct route for this line to the ice-free Yellow Sea. Besides the Siberian Railway, now open for traffic to Irkutch, and laid to Srietensk, the other lines open for regular traffic in 1899 were:

	Versts.		Versts.
Samarkand-Andijan.....	503	Tikhorets-Volga	505
Moscow-Brianski.....	355	Perm-Kotlass	817

A NAPHTHA PIPE LINE 160 miles long has been laid by the Trans-Caucasus R. R. Co. from Michailovo to Bannoi. The pipe is 8-ins. diameter.

AMERICAN COAL CARRIED TO NEWCASTLE, says a New Orleans news item, is soon to be an established fact. According to this item, Walter Parrott, a London banker, has closed a contract for 2,000,000 tons of coal to be exported from New Orleans within the next two years. The purchase price mentioned is 75 cts. per ton at the pit, 50 cts. for transport to New Orleans, and, with handling cost added, $1.50 per ton on board ship. The English syndicate will use its own ships, and the coal will come from Alabama.

CONSTRUCTION OF THE MISSISSIPPI RIVER EXTENSION OF THE CHICAGO & EASTERN ILLINOIS R. R.

(With full-page plate.)

The Chicago & Eastern Illinois Ry. has recently completed an extension of its St. Elmo Division from the terminal at Marion, Ill., southwest to the Mississippi River at Thebes, Ill., a distance of 62 miles. Connection will be made with the St. Louis Southwestern Ry. by means of transfer boats running between Thebes, Ill., and Gray's Point, Mo., a distance of one mile. Eventually a bridge will probably be built. These transfer boats carry 20 cars each. On the northern half of the line the country is very hilly, but on the southern half it is level.

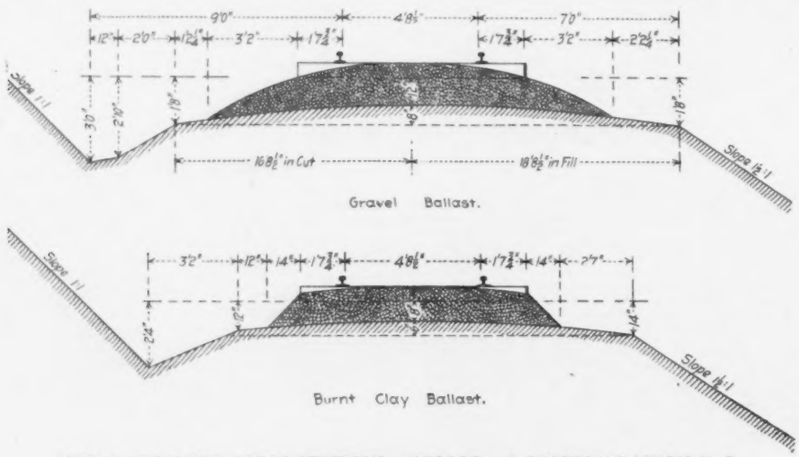


FIG. 1.—ROADBED CROSS-SECTIONS; CHICAGO & EASTERN ILLINOIS R. R.
W. S. Dawley, Chief Engineer.

The maximum grades are 0.95% (50 ft. to the mile), with a length of 2.5 miles against northbound trains and 1.45 miles against southbound trains. These are on tangents. On curves, the grades are compensated 0.06% per degree of curve. The sharpest curves are of 4½°, with easements. The alinement comprises 79.4% of tangent and 20.6% of curves. There are no tunnels. The grading involved the removal of approximately 1,500,000 cu. yds. of earth, and 108,000 cu. yds. of rock. The longest cut is 5,200 ft. in length, with a maximum depth of 32 ft. The longest fill is 2,100 ft. long, with a height of 28 ft. About 1,080 tons of cast-iron pipe, 16 to 42 ins. diameter, was used for culverts. There is one stone box culvert and one concrete culvert. There are 33 timber trestles of various lengths and two steel viaducts.

The Saline Creek Viaduct is 845 ft. long and 63 ft. high; with 1,118,300 lbs. of metal. The Grasshopper Creek Viaduct is 650 ft. long and 92 ft. high, with 950,000 lbs. of metal. These structures are built almost entirely of I-beams and channels, according to the special design of the Detroit Bridge & Iron Co., of Detroit, Mich., which is described more fully later on.

The width at subgrade is 15 to 20 ft. on fills, and 24 to 30 ft. in cuts. The width in cuts is even greater where the material excavated could be used within the limits of the extreme haul. About half the line is ballasted with burnt clay; furnished by the American Ballast Co., of Chicago, at a cost of about 60 cts. per cu. yd. in the track. The rest is ballasted with gravel, costing about 50 cts. per cu. yd. in the track. The line is single track throughout, and the roadbed cross-sections are shown in Fig. 1. There are about 1,800 cu. yds. of ballast per mile of single track. The specifications state that in shallow cuts, where the ditching is light, and in cuts where the back lines of the ditches are already 10 ft. or more from the rail, the width of roadbed is to be made 2 ft. wider than shown, so as to correspond with the roadway for embankment. If for any reason it is necessary to make the back of ditch more than 10 ft. from the rail, the additional width must be made in the back of the ditch. On double track sections of the C. & E. I. R. R., the width of roadbed is 29 ft. 8½ ins. in cuts and 31 ft. 8½ ins. on embankments, the gravel ballast being hollowed between the tracks to 7 ins. below the tops of the ties. The roadbed is flat on top for 13 ft. (c. to c. of tracks) and then curves down 8 ins. to the edge of roadbed at the prescribed width. A similar arrangement is adopted for passing sidings, but the side track is ballasted with engine cinders.

The ties are of cedar, white oak and water oak, costing 35 to 55 cts. each. They are 6×8 ins. section, and 8 ft. long. There are 17 ties to the rail on tangent, and 18 on curves. The oak ties are treated by the zinc process in the portable plant of the Chicago Tie Preserving Co., designed by Mr. O. Chanute, M. Am. Soc. C. E., and described in our issue of Aug. 17, 1899.

The rails are old 60 and 65-lb. rails, taken from the main line, where they were replaced by 80-lb. rails of the Am. Soc. C. E. section. The rails are laid with square joints on tangents and broken joints on curves. The joints are suspended, and are spliced by 24-in. angle bars with four bolts spaced 6 ins. c. to c. Split switches and spring-rail frogs are used. About five miles of the 60-lb. rails have Weber joints. The cattle guards are of the surface type, with wooden slats, and are nailed to the ties. There are about 50 highway grade crossings; two highways are carried over the line and one is carried under the line. One of the two railway grade crossings, that of the Mobile & Ohio R. R., at Tamm, is protected by an interlocking plant, while that of the Illinois Central R. R., at Marion, is protected only by "stop" signs. At Ullin the line crosses over the Illinois Central R. R. by a bridge. There are ten stations, and at Thebes will be a dock and terminal yard.

The surveys were commenced in January, 1899, and the contract was let March 31. Ground was broken April 20, 1899, and tracklaying was completed Jan. 13, 1900. The general contract for grading, trestling and masonry was let to Creech & Lee, of Kansas City, Mo., while the contract for bridge superstructures was let to the Detroit Bridge & Iron Works, of Detroit, Mich. Mr. W. S. Dawley is Chief Engineer of the Chicago & Eastern Illinois R. R., and was in direct charge of the work. We are indebted to him for much of the information given in the above article.

Viaducts Built of Structural Shapes.

As above noted, the two large steel viaducts on this line are built up almost entirely of I-beams, channels and angle irons, to the exclusion of plates. The designs were specially made because the railway company required the structures in a shorter time than it would have been possible to deliver them if the ordinary type of structure had been adopted, owing to the peculiar conditions of the metal market. Plates could not be obtained for any reasonable delivery, and the only thing to do was to practically eliminate them from the design. The beams, channels and angles were obtained promptly, and the structures were completed by the contract time. At the present time conditions have changed, and plates are as easy to get and almost as cheap as structural shapes, so that it is not likely that other structures will have to be built to this design. The bridges are designed for heavy twelve-wheel engines of 230,000 lbs., with 180,000 lbs. on the driving wheelbase. This is heavier than the twelve-wheel engines now in use, which weigh 172,000 lbs., with 142,000 lbs. on the drivers. These latter engines haul train loads of about 2,000 tons between Chicago and Danville, where the maximum grade is about 0.6%. One of the new twelve-wheel engines was illustrated in our issue of Feb. 22.

The general design of the Grasshopper Creek Viaduct is shown in Fig. 2. Each leg of the tower bents is composed of two steel channels set back to back against the flanges of an I-beam. The legs rest on masonry pedestals, and are capped transversely by pairs of 20-in. I-beams. These carry two longitudinal pairs of 24-in. I-beams, and also the ends of the deck trusses between the towers. These trusses are 47 ft. 5 ins. long over all, and 7 ft. 4 ins. deep, c. to c. of chords. Their construction is clearly shown in Fig. 3. Each top chord is composed of two 24-in., 80-lb. I-beams, with I-beam spacers instead of plate diaphragms. The bottom chord has two 12-in., 40-lb. channels. The verticals and diagonals are 15-in. I-beams, with connection plates of 24-in. I-beams. The floor beams are 15-in. channels, with horizontal pieces of channels to form the connection plates or gussets for the top laterals, which are steel angles. At the panel points of the lower chords are struts of 9-in. channels, the vertical diagonal bracing (angle irons) being riveted to these and the floor beam channels. The floor system consists of ties 8×12 ins., 12 ft. long, set on edge and spaced 14 ins. c. to c., being boxed out ½-in. over the girders. The guard timbers are 6×8 ins., laid flat, boxed

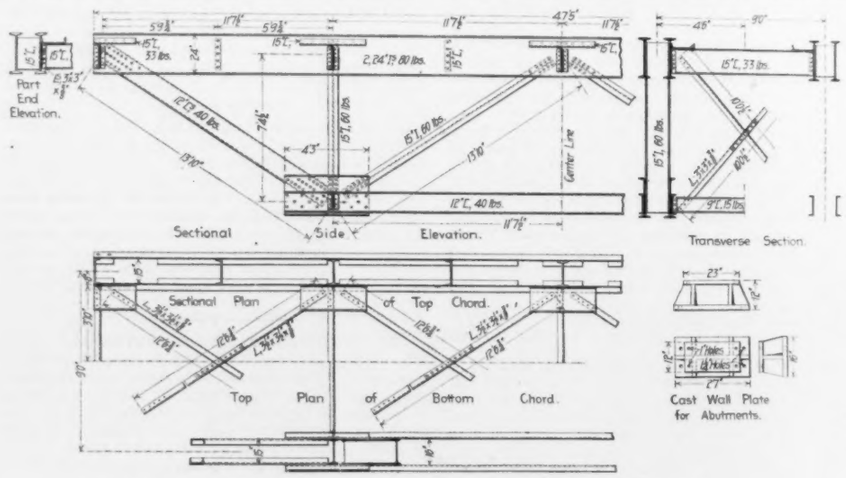


FIG. 3.—DECK TRUSS SPAN OF GRASSHOPPER CREEK VIADUCT.

out 1½ ins. for the ties. On the long spans (with two I-beams for the chords), these are bolted to alternate ties by ⅝-in. bolts. On the short spans (with three I-beams), they are secured to every tie by ¾-in. lag screws, 9 ins. long, with wrought-iron washers. For these screws, ¾-in. holes are bored in the guard timbers and ⅝-in. holes in the ties. The guard timbers are 9 ft. apart, c. to c. The bolts are in the center of the timbers, but the screws are staggered on each side of the center.

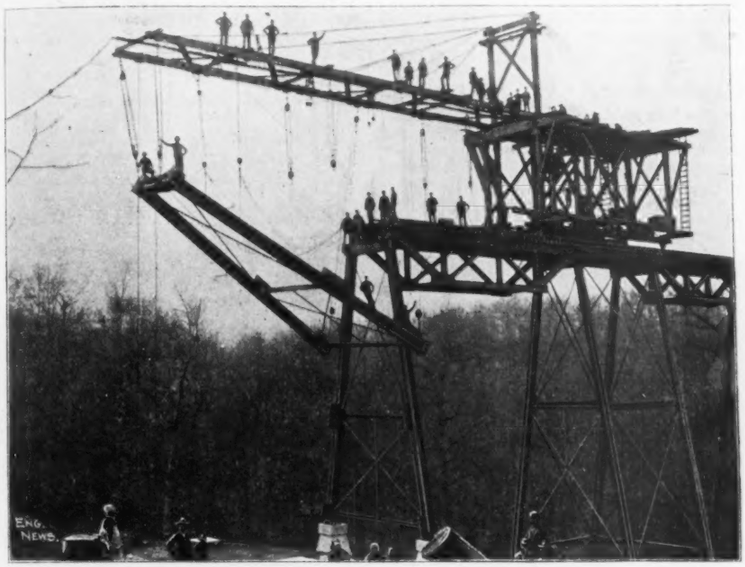


FIG. 4.—ERECTION OF GRASSHOPPER CREEK VIADUCT.

The material is all of soft open-hearth steel. The assumed live load consisted of two 300,000-lb. consolidation engines followed by 4,250 lbs. of train load per lin. ft. This assumed live load amounted to 1,100 lbs. per lin. ft. for the tower spans, and 1,200 lbs. for the intermediate spans.

The drawings in Figs. 2 and 3 show the Grasshopper Creek Viaduct. That over Saline Creek is of the same design, but has twelve long spans. Fig. 4 is a view showing the method of erection, with one of the tower bents being set in position from the overhanging frame of the traveler. Fig. 5 is a view of the completed structure. For the blue-prints and photographs of these interesting structures, which illustrate how special conditions are met by American bridge builders, we are indebted to the Detroit Bridge & Iron Works.

PUMPING GAS UNDER 20 LBS. PRESSURE FROM PHOENIXVILLE TO ROYERSFORD, PA.

A wrought-iron gas main, 3 ins. in diameter and 23,015 ft. long, conveying gas under a pressure of some 20 lbs., was put in operation on Dec. 29, 1899, between Phoenixville and Royersford, Pa. The theory that economy might be effected by using small pipe to convey gas under pressure was set forth last June in a paper read by Mr. F. H. Shelton, of Philadelphia, before the Western Gas Association, and reprinted nearly in full in our issue of Oct. 5, 1899. At the meeting of the New England Association of Gas Engineers, in February, Mr. Shelton described the gas main in Pennsylvania, just mentioned. The principal features of this case are shown by the following extracts, which compose the greater part of the paper:

Phoenixville, Pa., 28 miles above Philadelphia, on the Schuylkill River, is a manufacturing town of 10,000 population. Spring City and Royersford, some five miles above it, are smaller towns adjoining, on opposite sides of the river, and together form a gas district of 6,000 people. In the intervening distance between it and Phoenixville there are a few farm houses, and a county almshouse about midway. Each district has had a gas company for many years. The plant at Phoenixville was fair; that at Royersford was wretched. The Consolidated Schuylkill Gas Co., organized by myself and associates, acquired, Oct. 1, possession of both plants. It was decided to lay a high pressure connecting main from Phoenixville to Royersford, shut down the plant at the latter point and make all gas at Phoenixville. Work on the pipe line was started Oct. 27. Gas was pumped through within 64 days, Dec. 29. Since that date, the Royersford district has continuously procured its gas from Phoenixville, without either trouble or the suggestion of trouble.

The connecting pipe line is 23,015 ft., or about 4½ miles, in length, 3-in. size, and, of course, of wrought iron. To protect against corrosion, it was suitably coated after being strung along the road, and recoated in part after joining in the trench. The pipe is heavier than the ordinary; special threaded connecting sockets were used, and provision was made for protecting threads in shipment from pipe mills to ditch. It is bedded 3½ to 4 ft. deep in natural earth from end to end. Two thousand feet of the run was through rock requiring blasting; 10,000 ft. was through more or less shale and surface rock. Midway, it passes through an old-fashioned, covered, three-span, wooden bridge, 600 ft. long, crossing the Schuylkill River, being attached to the trusses 7 ft. above the drive level. Certain weather casing was here provided. At one point, over a stone arch road bridge, the pipe has but 15 ins. covering for a distance of 60 ft. It runs along a public highway throughout, excepting one stretch of 1,200 ft. through fields, private grounds. In its run it crosses under a three-track, trunk-line railroad. Valves are inserted at intervals, and adjoining the bridge, for use in the event of freshet or fire affecting the latter, and to facilitate the locating of any possible future leaks. Drips are provided. The run is fairly hilly. Some provision was made for contraction and expansion. As each 1,000 or 1,500 ft. of pipe were added, the line was tested throughout with air pressure, from a power compressor at the works, to 60 lbs. Despite all foresight and care, leaks were usually found. These were corrected, and a second test made, and not until the line stayed tight for hours, was final filling in of the ditch permitted. When the line was finished, it was bottle-tight, end to end, as proven by 60 lbs. test for hours. A wire was laid alongside in the trench from end to end, to enable the use in the future of any desired electric alarm, call bells, recording or signalling apparatus. A number of other construction details and adjuncts were incorporated, not necessary to here take up at length.

The pumping machinery at the starting point is a straight line, steam driven, air compressor of the usual type, but altered for handling gas. The steam and gas cylinders are each 8×12 ins., and the listed capacity at 140 revolutions of free air at atmospheric pressure is 5,820 cu. ft. per hour, with a duty of indicated horsepower of about 20. This compressor draws gas at ordinary pressure from the holder, a station meter with by-pass intervening. It is located near the water gas apparatus, and is attended to by the gas maker. No extra labor is employed. The space occupied is about 2×8 ft., and its weight is slightly over one ton. Its cost, including governor, gages, setting, freight, foundation, etc., was about $1,000. It is so run as to maintain 10 to 20 lbs. pressure on the pipe line. Provision was made for adding a duplicate compressor. Gages and other minor appurtenances were provided.

Principally because of quick delivery, two regulators or governors were used at the far end to reduce the pressure from the pipe line to the customary 2 or 3 ins. The first, with 3-in. connections, is built to reduce from 50 to 2 lbs. The second, with 6-in. connections, from 2 lbs. to 2 ins. They are of the dry, non-freezing diaphragm type. They are relatively inexpensive and seemingly perfect in action. The gas after being reduced in pressure at the gas premises in Royersford, passes into a gasholder of 10,000 cu. ft. capacity, from whence it passes into the street mains in the usual fashion. Connections are made, however, so as to enable by-passing the holder and the throwing of the governors directly on the town. The low pressure, 6-in. connections are sufficient for the present, but 8-in. will be a later size, and are partly in place. Suitable gages, safety appliances and other features are covered in the valve room at the terminus of the line. The equipment within the room represents a cost of about $500. Taking this figure and the cost of a compressor as about the sum already given, plus the cost of any given size pipe line laid per mile, one can approximate the cost of a complete high pressure installation.

As to operation: The gas handled is a straight illuminating water gas of 20 to 22 c. p., made from naphtha on a machine of the Lowe type, but of bad design. The single superheater is smaller in diameter than the generator and the fixing surface scant. This will ultimately be corrected, but observations so far have been upon gas made on the machine as above. Each morning the gas maker at Phoenixville runs the compressor for about two hours and pumps enough gas up the valley to fill the holder at the Royersford works. Pumping then ceases, and the Royersford and Spring City supply is maintained from the local holder. About 5 o'clock it is nearly emptied and pumping is resumed and continued, until perhaps 8 o'clock, when the holder is left full for the night. Royersford signals Phoenixville when to start and when to stop pumping. The compressor is run at a rate 25% less than its listed speed and handles thus in practice about 4,000 ft. per hour. This means a capacity of about 100,000 ft. per day. This is at relatively low pressure. By increasing the speed and the pressure and alteration of

FIG. 5.—GRASSHOPPER CREEK VIADUCT; C. & E. I. R. R.
Detroit Bridge & Iron Works, Builders.

governor adjustments, the pipe line can deliver much more in the future, when necessary. While pumping there is a loss of 2 to 3 lbs. pressure at the far end, due to friction. Between periods of pumping, the pressure equalizes and is left on the pipe line, and in 8 to 12 hours over night it drops from 1 to 3 lbs. This is not pipe line leakage, but is due to the consumption of customers so far taken off the line, changes in temperature, slight condensation, difference in gages, leakage around valve stems, etc. The cubic capacity of the line is about 1,200 ft.

The skeptics as to the success of the plan of handling —as herein described—illuminating gas at 20 lbs. pressure told me there would be considerable loss of candle power from the compression, that the governors would not be reliable, that condensation would trouble us, that the high pressure in the pipe would be dangerous, that corrosion and leakage would shortly follow, and that breakdowns of the pumping machinery would imperil the general supply. We have been working now for nearly two months; we do not find the trouble predicted.

In a second high-pressure line that will probably be installed shortly elsewhere, there will probably be used—for the sake of compactness—a single governor, instead of two as on the line herein described, including increased provision for the occasional cleaning of same, as well as a line meter that will measure gas at 50 lbs. pressure.

No photometrical observations have yet been made. We have been too busy with the completion of the line and other construction work to do aught else than get things finished and going in general. All of the figures mentioned in this paper are general and those so far observed, but they are felt to be practically correct.

We have just added midway a branch run of 2,000 ft. of smaller high-pressure pipe to the County Almshouse mentioned, with which we will handle a business expected to amount to 500,000 cu. ft. of gas in a year. Two house regulators at the far end of this run reduce the gas to the ordinary pressure and control the supply in the buildings, while a third regulator at the entrance to the Almshouse grounds controls a single lamp post. Each and all of these individual customers' service regulators are working as well as the main line regulators, cost but a few dollars each, and show the ease with which business can be taken care of en route on a high-pressure line. A firehouse has also been served by such a regulator for some weeks, and 17 houses on a cross street of 800 ft. length are now being connected.

It will be noted that the work done by the above pipe line and compressor is substantially the economical transfer of gas from one holder to another a few miles apart. The two months' operation has demonstrated, satisfactorily to me, that we can pump gas at high pressure, long distances, dependable as to both pumping and regulating mechanism, without trouble as to condensation, at low operating cost, without visible loss of candle power, and on a very low investment cost. I am expecting to further demonstrate that we can serve a town some miles distant with such an equipment and without the use of a holder. The regulators have so far worked perfectly on varying supplies and pressures in taking care of the gas passing through them into the holder, and there is no reason why they should not equally well handle and control the gas passing into the town direct. In fact, we have already so operated, tentatively but continuously for two or three days, in preliminary trials and entirely successfully with the holder by-passed and entirely shut off, and we are expecting shortly, by a lengthy trial, to fully prove the last point to be covered, namely, that a high-pressure line, with continuous pumping at a moderate rate and duplicate compressors, will safely and dependably supply a town direct, and that no holder is necessary.

In view of the uniformly smooth working, and the satisfactory results experienced, there is no question in my mind that in most instances the cheapest way to transmit gas long distances will be found to be by several pounds pressure through a very carefully laid small screw pipe. I and my associates are entirely satisfied with what we have done at Phoenixville on the lines described, and are expecting to shortly repeat it on a much larger scale in another and perhaps two other places.

While the pipe line here described is the first of which I have knowledge anywhere in which ordinary 22-c. p. illuminating gas is handled at 20 lbs. pressure, or thereabouts, it should be remembered that its successful working is but a confirmation of a closely similar operation that has for a long time been conducted by Mr. H. H. Edgerton, in Danbury, Conn., but which has practically been steadily overlooked or ignored by gas men at large. Mr. Edgerton, in pumping for nearly 10 years a 35-c. p., oil-water gas three miles through a 2-in. main, and up to 40 lbs. pressure, has long since shown the feasibility and low investment cost of supplying a town at a distance by high pressure. Credit for being the first to operate such a system should go to him.

A large part of the success of the Phoenixville line is directly due to the excellent work and care given to seemingly minor points, by Mr. B. S. Walters, the engineer in charge of construction, and I take pleasure in here giving him credit therefor.

Quite a lengthy discussion followed Mr. Shelton's paper, but no very convincing arguments were made against this method of conveying gas. To the objection that gas under such high pressure was dangerous, Mr. Shelton cited at some length the practice of distributing natural gas under high pressures, making use of governors at the houses. Regarding the joints, Mr. Shelton stated that "the sockets were special, in the sense that they brought the pipe ends butt to butt and had more of a taper than the ordinary socket."

The paper and discussion are given at length in the "American Gas Light Journal," of Feb. 26.

THE DELLWIK-FLEISCHER WATER-GAS PROCESS.*

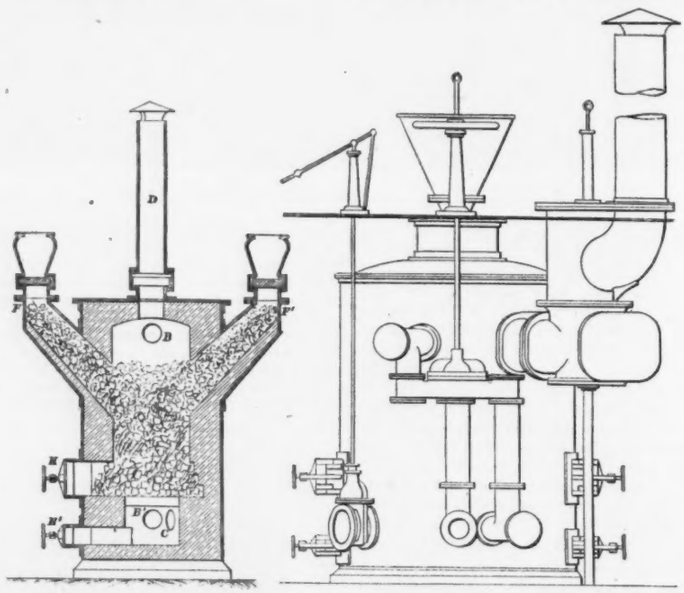
Water gas has long been known, and its adaptability for various purposes fully recognized. But the hitherto prevailing high cost of manufacture, caused by the low yield of gas obtained from the fuel and consequent inadequate utilization of the heat, has proved an insurmountable obstacle to its introduction. This obstacle has been removed by the Dellwik-Fleischer process, by which a utilization of the fuel is obtained fully equal to, and even surpassing, that obtained by the Siemens or Dowson processes. But in the water gas the heat is contained in a much more concentrated form than in Siemens or Dowson gas, the heating value per volume being 2½ to 3 times as high as that of producer gas, and its flame temperature also much higher. Water gas therefore offers advantages in many directions, which cannot be equaled by any other kind of fuel.

	Calories.	Calories.
18 units of steam, require for decomposition $2 \times 28{,}780$		= 57,560
12 units of carbon oxidized in the operation develop $12 \times 2{,}400$		= 28,800
Consequently leaving a balance of.....		28,760
for which provision must be made, or in other words, for the decomposition of 18 units of steam 28,760 calories must be developed by blowing with air.		

Of this heat only such portion is available as remains stored in the coke. It is, therefore, necessary to distinguish the available heat generated by the air blast as being the difference between the total quantity of heat developed, and the heat carried away by the blast gases.

On the supposition that the carbon is burnt respectively to CO and CO_2, in each case with the theoretically proper quantity of air, we find that per 12 units of C (carbon):

	Calories.	Calories.
A. By the older processes burnt to CO there are generated $12 \times 2{,}400$.....		= 28,800
The 12 C combining with 16 O escape as CO at 700° C., and the heat carried away by the CO (sp. heat = 0.248), is $28 \times 700 \times 0.248$.....	= 4,860	
The 16 O are accompanied by $16 \times 3.31 = 52.9$ N, which at 700° C. carry away (sp. heat of N = 0.244) $52.9 \times 700 \times 0.244$	= 9,035	= 13,895
Thus leaving available		14,905
B. By the Dellwig-Fleischer water-gas process, in which C is burnt to CO_2, 12 C combine with 32 O developing $12 \times 8{,}080$		= 96,960
The 44 CO_2 (sp. heat = 0.217) carry off at 1,000° C. $44 \times 1{,}000 \times 0.217$.....	= 9,548	
And $2 \times 52.9 = 105.8$ N, $105.8 \times 1{,}000 \times 0.244$	= 25,814	= 35,362
Thus leaving available in this case....		61,598



SECTION AND ELEVATION OF DELLWIK-FLEISCHER WATER GAS GENERATOR.

Comparative Value of Water Gas Generated by Ordinary Process and by Dellwik-Fleischer Process.

To explain the superiority of the Dellwik-Fleischer process, it is necessary to enter into a theoretical comparison between the thermal conditions of the old methods and the one described by the Dellwik patents.

As is well known, all practical water gas processes are of intermittent character, and consist in the heating up of a bed of fuel by means of an air blast, and the subsequent decomposition of steam in contact with the incandescent carbon thus heated. The older water-gas generators produce generator gas (CO + N) during the periods of heating, which occupy about 45 minutes of every hour, leaving a total of only 15 minutes for the water-gas production. The water-gas generators of the Dellwik-Fleischer system produce, on the contrary, no generator gas during the periods of heating, but only waste gas (CO_2 + N). For the periods of heating are required about 10 minutes of every hour, leaving a total of 50 minutes for the water-gas production, so that in the Dellwik generator the high yield of nearly 40 cu. ft. of gas per pound of coke is made possible, as against an average of 16 cu. ft. by the older processes. The following comparative calculation of the caloric conditions will show how large is the useful quantity of heat by the Dellwik-Fleischer water-gas process:

With the same consumption of fuel there remains therefore available by combustion to CO_2 (Dellwik) four times as much heat for the water-gas production as by combustion to CO (old methods).

That the yield of gas theoretically calculated is actually obtained in practice by the Dellwik generators, has been proved by various tests by authorities such as Professor Vivian B. Lewes, of London; Professor Bunte, of Karlsruhe; Professor Lunge, of Zurich, and others. Professor Lewes, in a lecture before the Incorporated Gas Institute, at Bath, in June, 1897, summarizes the results of his tests as follows:

One thousand cubic feet of water gas, containing 15 lbs. of carbon, are obtained by a total expenditure of 29 lbs. of carbon; so that over 51% of the carbon is obtained in the gaseous form, while the expenditure of the other 49% results in the hydrogen of the water gas.

The coke used in the experiments contained 87.56% of carbon, or 1,961.3 lbs. per (long) ton—equal to 15,846,304 thermal units °C., and this amount yielded 77,241 cu. ft. of water gas. The specific gravity of the water gas, as taken by the Lux balance, was 5,365, and its gross calorific value, as determined in Junker's calorimeter, was 4,089 thermal units. Hence the calorific value of the water gas from a ton of coke was 13,033,059.8 thermal units, or over 82% of the heating value of the total coke used in both generator and boiler.

From this calculation 20% of the coke has been taken as used for raising steam; but in a large installation this

*Reprinted from "Engineering," Jan. 26, 1900.

figure could be reduced, and the total heating value of the coke obtained in the gas slightly raised. The labor needed will be less than with the ordinary process, as less fuel has to be handled.

Water gas is composed of, approximately:

	Per cent.
Hydrogen	51
Carbonic oxide	41
Marsh gas	0.5
Carbonic acid	4.5
Nitrogen	3.0

Considering the great economy of production afforded by the Dellwik-Fleischer process, which, as just shown, produces nearly 40 cu. ft. of gas per pound of carbon, in vivid contrast to the older methods, which practically do not reach half that efficiency, it is quite natural that the high calorific power of water gas, its high flame temperature, its ready adaptability, and other excellent qualities, have gained general recognition, and assured its introduction for many purposes of manufacturing as well as for general distribution.

Use of the New Gas in Manufacturing Industries.

Turning from the actual production of the gas, it is interesting to note to what extent the Dellwik-Fleischer process has so far found practical application. Although it is only about two years since it was first brought before the public, there have already been built more than 30 generators (see illustration), with a total capacity of upwards of 40,000,000 cu. ft. per day, the gas being used for a great variety of purposes.

In the iron industry it is largely employed for welding. Thus the firm of Fitzner & Gampner, at Sielce, near Sosnovice, Russian Poland, have two large generators, and use the gas for welding boiler-flues, tubes, etc. Similar manufacturing is carried on by the Duisburger Eisen und Stahlwerke, Duisburg, Dillinger Huttenwerke, Dillingen-a-Saar, and Laurahutte, Silesia. At the last-named place masts for war vessels are largely manufactured; and it is illustrative of the speed in working which is attainable with water-gas firing, that while with coke firing a time of five months was consumed for the welding of a mast 66 ft. long and 7 ft. in diameter, the same work with water gas was done in seven weeks, or one-third the time, and with only one-half the number of workmen. It also speaks well for the Dellwik generators, that at three of the above-named works the erection of a first generator was speedily followed by an order for a second one.

At the Vulcan Iron Works, at Norrkoping, Sweden, Dellwik water gas is used not only for welding furnaces for upright boilers, boiler flues, tubes, etc., but the blacksmith's forge has also been adapted for gas-firing, to the perfect satisfaction of both managers, engineers, and workmen, the latter fully appreciating the cleanliness and freedom from smoke and soot, while the ever-ready gas fire allows them to regulate and watch the heat with far greater facility than is possible in an ordinary coal forge.

The Deutsche Rohrenwerke at Dusseldorf have recently started a large Dellwik-Fleischer water-gas plant for welding of tubes. At Reineckendorf, near Berlin, a Dellwik water-gas generator has been erected for open-hearth steel smelting.

At the Gute Hoffnungs Hutte at Sterkrade, Westphalia, the second largest ironworks of Germany, a large water-gas open-hearth furnace is being erected. Independently of an improvement in quality of the work turned out, it is certain that a very considerable amount of economy and time is gained in all installations of this kind, as compared with producer-gas firing. For brazing and soldering, water gas furnishes exceptional facilities in many kinds of manufacturing. One application for such purpose, where Dellwik water gas is in use, is at the Bicycle Works "Elite," of Fritz Evertsbusch, at Lennep, in Westphalia. For tempering and annealing there is a large field of utility for water gas, as it offers the means of the most regular and steady heat with a considerable saving in fuel. A Dellwik plant for this purpose has for some time been in use at the works of J. N. Eberle, at Augsburg, with such success that a second generator has recently been ordered.

It is, however, not only in the iron and steel and kindred industries that water gas has been applied. During the last two years Dellwik water gas has been introduced for a great variety of other purposes; such as, for instance, blowing and ornamenting of fine glassware at the works of Schulze-Berge & Schulz, at Lunen, Westphalia, and the manufacture of electric glow lamps at the Svea Glow Lamp Factory at Stockholm, Sweden, and the Societe Cruto, Turin, Italy. At both of these places the water gas is used not only for the finishing of the glass bulbs, but also for carbonizing the filaments. The economical results for this particular manufacture, as compared with coal gas and coke firing for the fiber furnaces, are such that the cost of construction of the water-gas works is fully covered by the saving made in two or three years.

At the De Haen Chemical Works, Hanover, a central heating and lighting installation of the Dellwik-Fleischer system has been contracted for.

Many further instances of the advantageous applications of water gas might be quoted; but from what has been said our readers will be able to form an idea of the developments in industry, which have been made possible by the cheap production of water gas by the Dellwik-Fleischer process.

Use of the Gas for Lighting and Heating.

In the gas industry proper, Dellwik-Fleischer water gas has made great progress on the Continent. A number of plants have been erected for the purpose of increasing the capacity of existing coal-gas works. The water gas is then mixed with the coal gas, the mixture being afterwards enriched by benzol to the desired candle-power. This system was first adopted at the town of Konigsberg, in Prussia, where in November, 1898, two Dellwik generators were started. The success was so apparent, both technically and financially, that a number of German towns have followed the example, and plants on this system have been started at Erfurt, Remscheid, and Iserlohn; while a number of large and small towns are contemplating similar installations.

In proportion to the steadily increasing supply of benzol, the price of this product has declined, until, at the present time, benzol-carburetted water gas, as admixture to coal gas, is produced at a considerably lower cost than is possible in Germany with water gas enriched by oil. As the erection of by-product coke ovens progresses in this country, and consequently the supply of benzol increases, it is certain that this system of increasing the capacity of coal-gas works will be largely introduced, as at present no other large demand for benzol can be found.

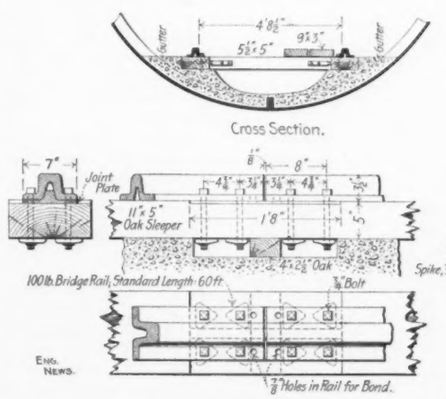
The steady rise in the price of petroleum, which at present is so largely used for carburetting purposes, has caused a tendency, even in the United States, toward reversion to coal gas. In view of the many advantages of water-gas manufacture, it is therefore easy to foresee that benzol is destined to supplant petroleum to a very large extent in the manufacture of gas for general distribution.

Uncarburetted water gas is excellently adapted for producing incandescent gas light, and when the low price at which water gas can be supplied for heating and cooking is taken into consideration, it is safe to predict that, whatever objections may at present be raised against the distribution of a non-luminous gas, this system is apt to be largely used in the future. A beginning has already been made by the introduction of uncarburetted Dellwik-Fleischer water gas at the little town of Brummen, in Holland, and at the towns of Osterfeld and Warstein in Westphalia, and Wiborg in Finland. At some of these places the installations are already completed, and the system has proved a brilliant success in every sense.

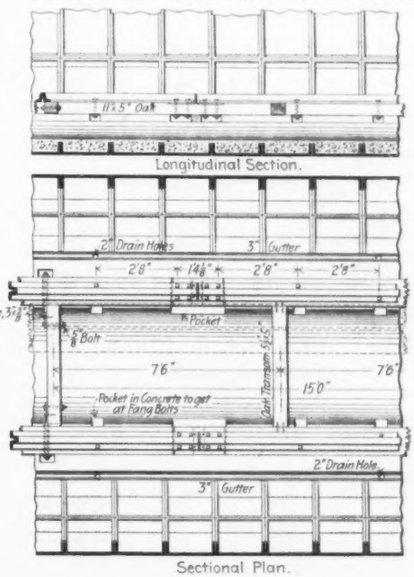
Use of the New Gas in Gas Engines.

In addition to what has been said of the various purposes for which water gas may be used, there is still one important utilization which has not been touched upon. This is for the generation of power. Mr. T. O. Paterson, engineer of the Birkenhead Gas Works, in a paper read before the Incorporated Gas Institute on June 15, 1899, gives the results of a very exhaustive investigation of the relative merits of various kinds of gas for motor purposes, from which it is apparent that Dellwik water gas is the cheapest agent for producing power by means of gas engines. In addition to the economical advantage over any other kind of gas, it may be pointed out that water gas, by reason of its composition, is very clean and free from dust, and consequently is less apt to clog the valves and wear the engine. A number of gas engines for uncarburetted water gas have been in successful operation for several years in various places on the Continent, and one of the largest firms manufacturing gas engines is prepared to guarantee a consumption of 30.5 cu. ft. per hour and horse-power. As, with coke at 9s. per ton, Dellwik water gas costs only about 3d. per 1,000 cu. ft., this makes the cost per hour and horse-power about 1-10d.

From the above account it will be seen that the Dellwik-Fleischer water gas is making rapid progress, and that Continental manufacturers eagerly avail themselves of the facility it offers for improving their methods of manufacture. In England the Messrs. R. & J. Dempster, Limited, of Manchester, who are sole constructors in Great Britain under the Dellwik patents, have erected a generator at their works, and are changing some of the existing old model water-gas generators to the Dellwik system. It is, however, to be expected that British manufacturers will not be behind their competitors on the Continent in introducing the most improved and labor-saving methods in their manufactures. The Dellwik water gas has already proved itself to be of the greatest importance in this direction; and as an effort is now being made to introduce it in this country, it is reasonable to expect that the success it has met on the Continent will secure for it attention and inquiry here.



TRACK CONSTRUCTION FOR THE CENTRAL LONDON RAILWAY.



TRACK CONSTRUCTION ON THE CENTRAL LONDON UNDERGROUND ELECTRIC RAILWAY.

The steel and concrete track construction designed for the New York Rapid Transit railway was described and illustrated in our issue of Dec. 14, 1899, and it may be of interest to compare this with the system adopted on the Central London Ry., the long underground electric line which is now approaching completion. This line consists of two single track, iron-lined circular tunnels, thus differing entirely from the New York line, except in regard to the construction of the latter under the Harlem River, where there will be two single track, iron-lined tunnels of 16 ft. outside diameter.

In the Central London Ry. there is a floor of concrete, so shaped as to form benches or supports for two lines of longitudinal oak timbers, 5×11 ins., with a broad drain between. At intervals of 7 ft. 6 ins. there are oak transoms, 5½ × 5 ins., fitted between the longitudinals. At alternate transoms there are strap bolts passing through the longitudinals, and bolted and spiked to the transoms. The other transoms are secured by 5-in. nails. Upon the transoms are two lines of planks, 9×3 ins., for the trackmen and others having to walk through the tunnel. The rails are 60 ft. long, of bridge section, 7 ins. wide and 3½ ins. high, weighing 100 lbs. per yd. They are secured to the longitudinals by fang bolts, 2 ft. 8 ins. apart, alternating on either side of the rail base. These bolts have square heads and are screwed down through heavy triangular nuts placed under the timbers, the nuts having points or fangs which bite into the wood and so prevent them from turning. The rails are laid with square joints, with a ribbed base plate under the joint, the rib fitting the hollow of the rail. The plates are ½×7×20 ins. The end of each rail is held by four fang bolts, and has also two ⅞-in. holes for the rail bonds. Pockets are formed in the

concrete to enable the track men to get at the nuts of the bolts, and as these pockets are 19 ins. long at the joints, an oak block, 4 × 2½ ins., is put in to prevent any deflection of the longitudinal timbers.

For the drawings from which our illustrations are made, we are indebted to Sir Benjamin Baker, M. Inst. C. E., and Mr. Basil Mott, M. Inst. C. E., engineers for the Central London Ry.

PROPER SIZES OF PIPES FOR HOT AIR HOUSE HEATING.

In a series of articles on "Furnace Heating," by Mr. Wm. G. Snow, published in "The Metal Worker," we find the accompanying table showing the sizes of air pipes for houses heated by hot air furnaces. In connection with this the advice is given that the cold air inlet to the furnace should be at least equal in cross-section to the combined cross-section of the pipes leading from the furnace. A branch from the cold air duct should permit air to be drawn from the interior of the house in extremely cold or windy weather. The data upon which the table is based are set forth in Mr. Snow's paper as follows:

Much larger furnace pipes are now used than formerly. This involves a greater original outlay and an increased running expense for fuel, but the householder is repaid by the more healthful conditions secured through the supply of an ample volume of warm air in place of a small volume of intensely heated air. The pipes should be so proportioned that the several floors will be heated equally. The accompanying table will be found useful in determining their size. It must be borne in mind, however, that in heating and ventilating work no rule or table can be successfully used without a certain coefficient of common sense to allow for varying conditions.

The main steps involved in the calculation of this table are:

1. The determination of the loss of heat through the walls, windows and floor or ceiling of the room.
2. The volume of warm air required to offset this loss.
3. The velocity of air in the pipes.

The loss of heat is calculated by first reducing the total exposure to equivalent glass surface. This is done by adding to the actual glass surface one-quarter the area of exposed wood and plaster or brick walls and one-twentieth the area of floor or ceiling to cover the loss of heat to non-heated basement or attic. Ten per cent. is added where the exposure is severe to cover the increased loss of heat by transmission and by the leakage of air. The window* area assumed in calculating the table is one-fifth, or 20% of the entire exposure of the room. From the inspection of a number of plans this ratio was found to represent a liberal allowance for glass surface.

Having obtained the equivalent of glass surface (E. G. S.) multiply by 85 (the loss of heat per sq. ft. of glass per hour with 70° difference in temperature). The product will be the total loss of heat by transmission per hour.

The volume of warm air required to offset this loss depends on its temperature, which generally ranges from 120° to 140° in zero weather. Assuming the temperature of the entering air to be 140° and that of the room to be 70°, the air escaping at approximately the latter temperature will carry away one-half the heat brought in. The other half, corresponding to the drop in temperature from 140° to 70° is lost by transmission. With outside temperature zero, each cubic feet of air at 140° brings into the room 2.2 heat units. Since only one-half of this, or 1.1 heat units, can be utilized to offset the loss by transmission, to ascertain the volume of air per hour at 140° required to heat a given room, divide the loss of heat by transmission by 1.1; the quotient is the volume sought. This result divided by 60 gives the number of cubic feet per minute. Having determined the volume of air required per minute, if we know the velocity with which it will travel through the pipes, their area in square feet is readily determined by dividing the volume by the velocity in feet per minute.

In calculating the table, maximum velocities of 280 and 400 ft. were used for pipes leading to the first and second floors respectively. These velocities are readily attainable in practice. They are lower than those commonly assumed for straight vertical flues, but this is accounted for by the greater resistance to the passage of air through the nearly horizontal basement pipes, and through elbows, nettings and registers. The size of the smaller pipes was based on lower velocities, according to their size, to allow for their greater resistance and loss of temperature.

TABLE IV.—Showing the Proper Size of Furnace Pipes to Heat Rooms of Various Dimensions when Two Sides are Exposed.

Width of room. ↓ / Length of room. →	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
8	7	7	7	7	7	7	8	8	8	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	8	8	8	8	8	8	9	9	9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
9	..	7	7	7	7	8	8	8	8	8	8	8	..	..	..	..	..	..	..	..	..	..	..
	..	8	8	8	8	9	9	9	9	10	10	..	..	..	..	..	..	..	..	..	..	..	..
10	..	..	7	7	8	8	8	8	8	8	8	9	9	..	..	..	..	..	..	..	..	..	..
	..	..	8	8	9	9	9	9	10	10	10	10	10	..	..	..	..	..	..	..	..	..	..
11	..	..	..	8	8	8	8	8	8	8	9	9	9	9	9	..	..	..	..	..	..	..	..
	..	..	..	9	9	9	9	10	10	10	10	10	11	11	11	..	..	..	..	..	..	..	..
12	..	..	..	..	8	8	8	8	8	9	9	9	9	9	9	10	10	..	..	..	..	..	..
	..	..	..	..	9	9	10	10	10	10	10	11	11	11	11	12	12	..	..	..	..	..	..
13	..	..	..	..	..	8	8	8	9	9	9	9	9	9	10	10	10	10	10	..	..	..	..
	..	..	..	..	..	10	10	10	10	10	11	11	11	11	12	12	12	12	13	..	..	..	..
14	..	..	..	..	..	..	8	9	9	9	9	9	9	9	10	10	10	10	10	10	10	..	..
	..	..	..	..	..	..	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	..	..
15	..	..	..	..	..	..	..	9	9	9	9	9	10	10	10	10	10	10	10	10	11	11	11
	..	..	..	..	..	..	..	10	11	11	11	11	12	12	12	12	13	13	13	13	13	13	13
16	..	..	..	..	..	..	..	..	9	9	9	10	10	10	10	10	10	10	10	11	11	11	11
	..	..	..	..	..	..	..	..	11	11	11	12	12	12	12	13	13	13	13	13	13	13	13
17	..	..	..	..	..	..	..	..	..	9	10	10	10	10	10	10	10	10	11	11	11	11	12
	..	..	..	..	..	..	..	..	..	11	12	12	12	12	13	13	13	13	13	13	13	13	14
18	..	..	..	..	..	..	..	..	..	..	10	10	10	11	11	11	11	11	11	12	12	12	12
	..	..	..	..	..	..	..	..	..	..	12	12	12	13	13	13	13	13	13	14	14	14	14
19	..	..	..	..	..	..	..	..	..	..	..	10	11	11	11	11	11	11	12	12	12	12	12
	..	..	..	..	..	..	..	..	..	..	..	12	13	13	13	13	13	13	14	14	14	14	14
20	..	..	..	..	..	..	..	..	..	..	..	..	11	11	11	11	11	12	12	12	12	12	12
	..	..	..	..	..	..	..	..	..	..	..	..	13	13	13	13	13	14	14	14	14	14	14

Temperature at register, 140°; room, 70°; outside, 0°. Rooms 8 to 17 ft. in width assumed to be 9 ft. high; rooms 18 to 20 ft. in width assumed to be 10 ft. high. For other heights, temperatures or exposures make a suitable allowance. When first floor pipes are longer than 15 ft., use one size larger than that stated.

One 12-in. pipe	=	two	9-in. pipes.
" 13-in. "	=	"	10-in. "
" 14-in. "	=	"	11-in. "
" 15-in. "	=	"	12-in. "
" 16-in. "	=	"	12-in. "
" 17-in. "	=	"	13-in. "

In the space opposite the numbers indicating the length and width of room, the lower number shows the size pipe for first floor, the upper number the size pipe for second floor.

For third floor use one size smaller than for second floor.

For rooms with three exposures increase pipe given in table in proportion to the exposure.

For halls use pipe of ample size to allow for loss of heat to second floor.

*Double windows, when tightly put in, transmit about three-fifths as much heat as a single window.

IRON REMOVAL FROM GROUND WATER AT FAR ROCKAWAY BY SLOW SAND FILTRATION.

(With full-page plate.)

A simple and apparently efficient plant for the removal of iron from the ground water supplied by the Queens County Water Co. has been in operation since August, 1896. It consists of a slight amount of aeration, followed by slow sand filtration.

The original works of the Queens County Water Co. were built in 1884. The works now supply sections of Greater New York (annexed Jan. 1, 1898) known as Far Rockaway, Arverne and Rockaway Beach, and the adjacent villages of Lawrence, Cedarhurst, Woodfern and Fenhurst, outside the city limits. Of the outside territory only Lawrence is incorporated, the other places being districts of the town of Nassau. About one-half the area supplied and three-fourths of the winter population are inside the city limits. The total population supplied is estimated at 10,500 in winter and 75,000 in summer, the territory including some of the most attractive seaside resorts in or near New York city. Notwithstanding this large range of population the water consumption in 1899 averaged only some 1,000,000 gallons a day, ranging from 600,090 to 1,800,000 gallons, the maximum hourly pumpage being at the rate of 3,600,000 gallons a day. Of the 1,800 services in use about 500 are metered.

The original source of supply was from wells at Far Rockaway. In May, 1893, the company began to supply water from new wells, a few miles distant, and since then the old wells and pumping station have been abandoned. There are now 16 6-in. wells 150 to 180 ft. deep, and 45 4-in. wells 30 to 50 ft. deep, the latter having been put down first. All the wells overflow slightly.

After a slight exposure to the air iron precipitates from the water drawn from both the shallow and deep wells. This gave the consumers trouble from the start, the reddish color of the water causing great annoyance.

Experiments with a slow sand filter having an area of 10 sq. ft. were carried on for between two and three years before the permanent filter plant was put in operation in August, 1896. The two filter beds are located close by the pumping station, as is shown by the plan in Fig. 1 and by the view, Fig. 2. Each bed has an area of 20,000 sq. ft., making nearly an acre in all. A 4,000,000 and a 6,000,000-gallon low lift pump are provided to lift water from the wells to the filter beds, and two 2,000,000 and one 4,000,000-gallon pumps supply the regular service, drawing from a clear water well 25 ft. in diameter, shown in Fig. 1. The details of construction are all indicated by Fig. 1. Although an air compressor previously bought by the company for another purpose was installed for aeration, it has never been used; the slight aeration at the turned-up end of the influent pipe giving all the aeration needed.

The sand for the filter beds was obtained close at hand, that for one bed being screened while the other was hauled in without screening.

During the busy season of 1899, which began about the middle of June and extended through July and August, the whole filtration area was scraped twice, or each bed once in 19 days. Four men work about two days to clean one bed, scraping the deposit up into piles with wooden hoes and removing it by means of wheelbarrows, running on plank. At the start there was so much vegetable growth on the surface that it and the deposit together would roll up like thick, wet paper. It appears that there has been less of this growth in later years, but the ordinary summer scrapings are said to remove only ¼-in. of sand. After such scrapings the surface of the bed is loosened with garden rakes. If the weather is favorable the beds are cleaned once or twice in the winter, and in the spring a deeper layer, say ¾-in., is removed, and the beds harrowed to a depth of 7 ins. with a harrow set with vertical teeth. There are no other scrapings besides those mentioned. The dirty sand is dumped in the woods near by. None of it has been washed, and no new sand has been added. In fact, the original thickness has been but slightly reduced as yet. The small winter consumption not only requires the filtration of a minimum amount of water, but with the small pumpage the water contains less iron than in summer when the pumpage is larger.

When the plant was started several analyses were made by Dr. Albert R. Leeds, of Hoboken, N. J., which satisfied the company that the plant was fulfilling its object. Since the consolidation of Far Rockaway with Greater New York a number of analyses have been made at the Mt. Prospect laboratory of the Brooklyn water-works.

Through the courtesy of Mr. Robt. Van Buren, Engineer-in-Charge of the Department of Water Supply, Borough of Brooklyn, and of Mr. G. C. Whipple, Biologist and Director of the Mt. Prospect laboratory, we are enabled to give the accompanying table of analyses. It will be noticed that the iron in the unfiltered water ranges from 1.9 to 4.5 parts per 1,000,000, averaging 2.48, and that all of it is removed by filtration; that all the crenothrix are removed; that the hardness and organic matter are materially decreased, but the very few bacteria remained practically, in the two counts of raw and filtered water made. Mr. Bettes states that they obtain "perfectly satisfactory results when filtering at a rate far in excess of that originally contemplated." According to Hazen's "Filtration of Public Water Supplies":

The plant was built to treat easily 3,000,000 gallons per day, and has occasionally treated a larger quantity. Either filter yields the whole supply while the other is being cleaned. The rate of filtration in this case was made lower than would have otherwise been necessary, as there was an alternate supply, namely, the water from two brooks, which could be used on occasions, and to purify which a lower rate of filtration was regarded necessary, than would have been required for the well-water. The removal of iron is complete.

The cost of the filters complete, including piping and connections with the pumps, was $33,000. The low lift pump cost $3,000 in addition.

The cost of operation, including the extra pumping, cannot be given with much accuracy, it being difficult to apportion the cost of running the pumping station between the low and high lift pumps, no separate records being available. Assuming that one-fourth of the coal and one-third of labor at the pumping station is due to the low lift pumps, the total cost of supplying water to and cleaning the filters in 1899 was $5.96 per 1,000,000 gallons, not including interest and depreciation. The cost of pumping is unduly high on account of the relatively small consumption during eight months of the year.

The principal available figures regarding the

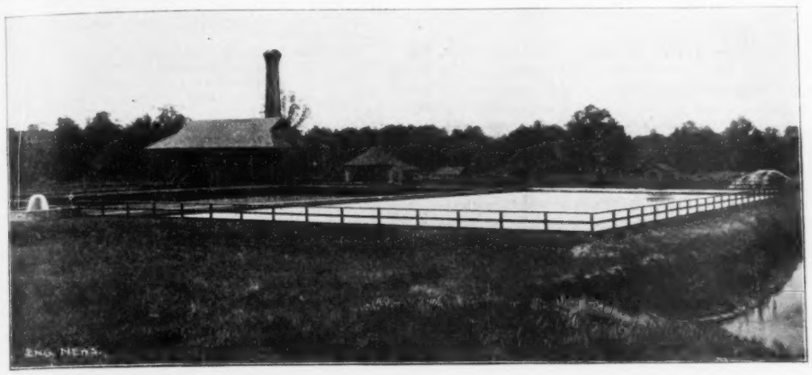


FIG. 2.—VIEW OF FILTER BEDS AND PUMPING STATION, QUEENS COUNTY WATER CO.

operations of the filter plant during eleven months of 1897 and the years 1898 and 1899 are shown by the accompanying table:

Operations of the Far Rockaway Filter Plant, 1897-9.

	Yield of filters, gallons. No. 1.	No. 2.	Total.	Total pumped to filters, gallons.	Cost of cleaning.
1897*	152,157,541	74,292,284	226,449,825	.....	$56
1898	169,259,045	145,213,936	311,472,971	334,426,000	63
1899	134,372,175	233,028,502	367,400,677	378,837,131	158
	455,888,751	449,534,722	905,323,473	.....	$277

*11 months.

From these figures it appears that the daily yield of the filters was 678,000 gallons for the eleven months of 1897, 854,000 gallons in 1898 and 1,007,000 in 1899. Also that 905,323,000 gallons of water have been filtered with an expenditure of $277 for cleaning, or about 30 cts. per 1,000,000 gallons, making no allowance for the sand which must be replaced some day.

The filters were designed and constructed by Mr. Chas. R. Bettes, Assoc. M. Am. Soc. C. E.; Chas. Brush & Co. were Chief Engineers for the company when the work was done, and Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., was Consulting Engineer. Mr. Bettes is now Chief Enginer of the works, and we are indebted to him for information and courtesies extended in the preparation of this article on a visit of a member of our editorial staff to Far Rockaway in November, 1897, and again in January, 1900. Mr. Franklin B. Lord is president, and Mr. Gurdon S. Buck is secretary of the Queens County Water Co.

AN AMERICAN ENGINEER'S POCKET-BOOK OF 1834, AND EARLY WORKS ON SURVEYING.

An early American engineer's field-book has been sent to this office by Mr. Walter M. Dawley, C. E., of the Baltimore & Ohio Southwestern R. R. Co. It is entitled "The Surveyor's Pocket-Book," compiled by A. Bourne, and published at Chillicothe, O., in 1834. This Mr. Bourne was one of the pioneer land surveyors of Ohio in the opening years of the 19th century, and was largely engaged in locating the Virginia military land warrants in the Virginia Military District of Ohio. Evidently taking a leaf from his own experience, he here attempts to produce a book that "will be very portable and capable of being used as a field-book on all occasions." And in this he is successful, as the pocket-book has only 147 pages, measures 6¼ by 4 ins., and is substantially bound in leather.

He proposes to issue "a book of reference for practical business men," and he introduces his subject by short dissertations upon arithmetic, algebra, geometry and plane and spherical trigonometry. The part devoted to surveying chiefly relates to the laying out of government lands by the use of the compass. The author discusses the variations of the compass and the method of determining this variation by observations on the Pole Star and its neighbors. Leveling is also briefly touched upon, and we then have a discussion of mechanics and hydrodynamics.

Under the head of roads we have a description of the method of laying Telford pavement and notes upon the tractive force required with given loads on roadways of different materials. Very considerable space is devoted to canal location and construction; and, as the usefulness of canals depends on the quantity of water available, Mr. Bourne gives a table "for ascertaining the annual rainfall for any latitude between 5° and 90°." For ascertaining the quantity of water in large streams he gives a crude but generally correct method for cross-sectioning the river and ascertaining its velocity; and he concludes this portion of his work by general rules for estimating the cost of canals.

The tensile and crushing strength of a limited list of materials, the stiffness of beams of varying materials and span, the expansion of metals under heat, and a list of "useful numbers and quantities" bring us to the tables which form a considerable part of this pocket-book. These tables include: A traverse table, the logarithms of numbers, logarithmic sines and tangents, natural sines and tangents, apparent time of transit of the Pole Star for Jan. 1, 1834, angular distance of the Pole Star, correction of random lines, and bases and perpendiculars and the angles they subtend.

For his time and for the purpose intended Mr. Bourne produced a creditable and useful engineers' pocket-book, and in its contents and portable character it is one of the earliest of which we have knowledge published by an American. There were earlier American works on surveying alone, as we find that Gibson's Surveying—an English work—was published in New York in 1780, and republished in 1798 with "alterations and amendments adapted to the use of American surveyors." This additional matter, however, mainly consisted of the method for computing areas, devised by David Rittenhouse, of Philadelphia. In 1799, Zachariah Zess, a schoolmaster of Wilmington, Del., issued his "Compendious Treatise on Practical Surveying, Concisely Defined, Methodically Arranged and Fully Exemplified." It was an excellent book of its kind, with 212 pages of text and 152 pages of tables. In 1800 or 1801, Amos Eaton, later the Principal of the Rensselaer Polytechnic Institute at Troy, N. Y., published his "Art Without Science," wherein "mensuration, surveying and engineering are divested of the speculative principles and technical language of mathematics." This was a small 18mo. pamphlet, and it was reprinted in 1830 and enlarged to 8vo. form and 96 pages. Abel Flint, of Connecticut, in 1804, published a popular work on trigonometry and surveying, the last editions of which appeared about 1852. The well-known "Surveying" of John Gummere, of Philadelphia, appeared in 1814, and it went through many editions and is still used to some extent. Other works on this subject were published prior to 1834; but they were all text books, somewhat ponderous in form as a rule, and were not portable field-books of the character of that issued by A. Bourne.

English publications on this subject were issued at much earlier dates, and among the oldest issues it is sufficient to here mention the following: "The Moste Profitable and Commendable Science of Surveying Landes, Tenements and Hereditamentes," "drawen and collected by the industrie of Valentine Leigh," "Imprinted at London for Andrew Munsell, Anno Domini 1562." This treatise touched very lightly upon what would now be called the art of surveying, and Mr. Leigh prefers to the "rodde" a line "of foure Pearches of lengthe, and at every pearche ende a knot." He selects this line as being "spedier, most commodious and also of most antiquitie," but he warns the user to see to it that this line is "well seared with hoate Waxe and Rosen, to avoide stretching thereof in the wete, and shrinking in the drought." He commences his "Parties or Divisions of an Acre, according to the Statute," with the time-honored statement that "Three Barley cornes, faire and rounde, taken out of the myddest of the Eare, maketh an Inche." One piece of advice to the surveyor, contained in this book, is as sound now as it was three centuries and a half ago. Mr. Leigh advises the "surveiour" to have "redy provided a Paper-boke, wherein he may roughly and spædily note as he goeth about the mannour;" and he sensibly adds that if he makes these notes on loose sheets they may be lost or misplaced, and were "perchaunce as good never written." "The Compleat Surveyor" of William Leybourn, published "at the sign of the Bible on Ludgate Hill," London, 1653, was a great advance upon the above work, as Mr. Leybourn sets forth the art of the surveying of land "by the Plain Table, Theodolite, Circumferentor and Peractoe;" though he prefers the "Plain Table" as doing whatever may be done by the other instruments, or "any other yet invented," and "in many cases much better." In the above list the "circumferentor" was practically a surveyor's compass; but just what the "peractoe" was we have not ascertained, as the book itself is not available.

Analyses of Water Before and After Slight Aeration, Followed by Slow Sand Filtration, Queens County Water Co., Far Rockaway (L. I.), N. Y.

(Parts in 1,000,000.)

	Date of collection.	Color.	Total residue on evap'n.	Nitrogen as Ammonia. Albuminoid.	Nitrogen as Ammonia. Free.	Nitrites	Nitrates.	Chlorine.	Iron.	Hardness.	Alkalinity.	Bacteria pr c.c.	No. of Stand. units, creno-thrix pr c.c.
Before Filtration	Oct. 24, 1898.	0.06	46.0	0.002	0.024	0.000	0.02	3.2	4.50	....	....	10	.....
	Feb. 24, 1899.	.07	46.0	.010	.024	.000	.00	3.4	2.00	22.0	13.8	27	1,000
	May 26, 1899.	.05	42.0	.002	.020	.000	.02	3.6	1.90	11.0	....	..	3,000
	Aug. 22, 1899.	.17	44.0	.002	.012	.003	.04	4.0	1.90	17.0	....	..	.....
	Feb. 15, 1900.	...	41.0	.008	.012	.001	.04	3.6	2.10	14.5	....	..	800
	Average	0.09	43.8	0.005	0.018	0.001	0.02	3.6	2.48	16.1	13.8	19	1,600
After Filtration	Oct. 24, 1898.	0.02	41.5	0.016	0.006	0.000	0.00	3.4	0.00	....	....	11	.....
	Feb. 24, 1899.	.00	40.5	.010	.002	.000	.00	3.4	.00	19.5	10.1	26	0,000
	May 26, 1899.	.00	40.5	.004	.000	.000	.00	3.6	.00	8.0	....	..	0,000
	Aug. 22, 1899.	.00	40.0	.002	.000	.000	.00	4.2	.00	9.5	....	..	.....
	Feb. 15, 1900.	.00	36.5	.008	.000	.000	.00	3.6	.00	14.5	....	..	.....
	Average	0.00	39.8	0.008	0.002	0.000	0.00	3.6	0.00	12.9	10.1	19	0,000

Note.—The water from the wells is without turbidity and sediment, but on standing the iron precipitates as Fe_2O_3. None of the samples showed odor, cold or hot.

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ADVERTISING RATES: 20 *cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.*

What is the life or what is the rate of corrosion of iron or steel embedded in concrete and placed below water level? Will the concrete by its close contact with the iron effectually prevent the access of oxygen-carrying water to the surface of the metal and so prevent its corrosion; or, on the other hand, will there be a slow flow through the pores of the concrete, by which a layer of rust will be gradually formed on the surface of the metal? Further, will such a layer of rust, supposing it to be formed, break the bond between the metal and the concrete, and perhaps by its expansive force weaken or fracture the concrete itself? Will such a destructive process continue indefinitely until the entire failure of the structure occurs?

Some of these questions, we believe, are being asked by careful engineers in considering the design of foundations for important structures in which it is desired to use concrete and steel in combination. We know of no authentic facts bearing on them. It is much to be desired that such facts should be put on record in engineering literature. If any of our readers can furnish us any such information we shall be glad to hear from them.

A drawing on another page of this issue shows how one careful and conservative engineer solved this problem, in designing the concrete bottom for a pump well in connection with a filter plant. It will be seen that 6 × 8-in. spruce timbers are embedded in the concrete. At first sight such a construction may seem cheap and perishable, but is it not possible that those timbers may outlast iron similarly placed? The use of wood and concrete in combination in dry situations has been justly criticized; but is not the case reversed when work is permanently exposed to moisture? The grillage foundation, of timber covered with concrete, is common practice. Is not such a use of timber and concrete as that which Mr. Bettes adopted equally durable?

It may be objected, perhaps, that the difference in elasticity of timber and concrete is an objection to their use together; but there occurs to us in this connection a so-called fireproof floor, built of wooden beams with concrete filled in between which was used in several large structures in Philadelphia a dozen years ago, including the Library Building of the University of Pennsylvania.* So far as strength and stiffness was concerned that construction appeared to meet all requirements. Its abandonment was due to other obvious objections. We allude to it here merely to illustrate our suggestion that the use of timber and concrete in combination may deserve a larger place in engineers' designs. Until we have more definite knowledge as to the extent to which a concrete covering protects steel from corrosion when under water, there may be reason to prefer timber as the more reliable material.

The frauds in the Savannah Harbor work, for which O. M. Carter, formerly a Captain in the Corps of Engineers, is now under sentence of imprisonment, are again brought into public notice this week. A United States Grand Jury at Savannah has called the attention of Congress to the astonishing delay encountered in the attempt to bring to justice the members of the contracting firm with whom Captain Carter was convicted of conspiracy. In New York, Judge Addison Brown, of the United States District Court, handed down a decision on April 4, refusing to order the transfer of the indicted persons to the Savannah district.

Shakespeare makes Hamlet, in his famous soliloquy, speak of:

> "The oppressor's wrong, the proud man's contumely, the law's delay, the insolence of office and the spurns that patient merit of the unworthy takes."

The whole quotation was never more graphically exemplified than it has been in the history of the Carter case; but it is "The law's delay" on which attention is now deservedly concentrated. It may be of interest to present a brief chronology of the Carter case from the beginning, to see just how significant this delay has been. The record is as follows:

1889, May 31.—Sworn statement made by W. R. Curtis, an assistant engineer in the Government employ, charging Carter with collusion with certain contractors (the same with whom his conspiracy was proven before the court-martial nine years later). An investigation was held, Carter was exonerated, and the unfortunate engineer who was too honest to hold his tongue, died from disappointment and mortification at the fruitless outcome of his endeavor to protect his country from robbery.

1897, August 14. Capt. C. M. Gillette, who succeeded Capt. Carter in charge of the Savannah district on July 20, reported to the Chief of Engineers his discovery of irregularities in the conduct of the Savannah Harbor work.

1897, Aug. 21.—Gen. P. C. Hains, Division Engineer, instructed to proceed to Savannah and conduct investigation.

1897, Sept. 7.—Gen. Hains made a report unfavorable to Capt. Carter, the whole matter was laid before the Secretary of War, and Capt. Carter, then in London, was ordered to report at Washington.

1897, Sept. 13.—A Board of Engineer officers, Col. Gillespie, Major Raymond and Major Adams, was convened at Savannah to inquire into the charges against Capt. Carter.

1897, Nov. 13.—Board of Engineers presented its report recommending that Capt. Carter be tried by court martial. The examination of the Board was most thorough, occupying nearly two months. A great number of witnesses were examined and the entire record of the inquiry was over 1,000 pages in length.

1897, Nov. 15.—Report of Board of Engineers referred to Judge Advocate General's office for examination and preparation of formal charges.

1897, Dec. 2.—Court martial ordered to meet at Savannah, on Jan. 12, for the trial of Carter.

1897, Dec. 20.—Copy of formal charges and specifications transmitted to Carter.

1898, Jan. 11.—Capt. Carter placed under arrest.

1898, Jan. 12.—Trial by court martial begun.

1898, April 30.—Court martial adjourned, and its findings reported to Secretary of War. Record submitted to Judge-Advocate General.

1898, July 3.—Judge-Advocate General reported to Secretary of War his approval of the findings of the court martial.

1898, July 12.—Record and findings submitted by Secretary of War to Hon. Geo. F. Edmunds, with request for an opinion.

1898, Oct. 8.—Report and opinion of Edmunds delivered to Secretary of War.

1898, Oct. 24.—Record submitted by Secretary of War to President McKinley.

——, ——. —.—Matter referred by the President to Attorney-General Griggs.

——, ——. —.—Attorneys for Carter submitted an argument and brief to Attorney-General.

1899, May 13.—Col. Thos. F. Barr, Asst. Judge-Advocate-General, U. S. A., made formal reply to the statements of Carter's attorneys.

1899, June 20.—Brief in defense of Capt. Carter submitted to Attorney-General by Wayne MacVeagh.

1899, Sept. 27.—Final oral plea for Carter made by MacVeagh.

1899, Sept. 29.—Attorney-General Griggs reported to the President his opinion that Carter had been proved guilty on the principal charges against him.

1899, Oct. 1.—President McKinley approved findings and sentence of court martial. Capt. Carter placed in prison on Governor's Island.

1899, Oct. 3.—Carter's attorneys obtained writ of habeas corpus on claim that both fine and imprisonment cannot be imposed for the same offense.

1899, Oct. 4.—Habeas corpus case argued before Judge Lacombe.

1899, Oct. 24.—Judge Lacombe rendered decision denying writ.——Appeal taken to U. S. Circuit Court of Appeals.

1899, Nov. —.—Wayne MacVeagh made plea to the President for commutation of Carter's sentence.

1900, Jan. 9.—Carter's appeal argued before U. S. Circuit Court of Appeals.

1900, Jan. 24.—Court of Appeals affirmed decision of Judge Lacombe.

1900, Feb. 1.—Petition for writ of certiorari made to U. S. Supreme Court by Carter's attorneys.

1900, Feb. 8.—Court of Appeals granted stay of execution of Carter's sentence pending action of Supreme Court.

1900, Feb. 27.—Supreme Court refused petition of Carter's attorneys, who obtained a writ of error returnable before U. S. Supreme Court, March 26.

1900, April 9.—Petition for writ of error argued before U. S. Supreme Court.

Proceedings in the Case of the Contractors.

1899, Dec. 8.—Federal Grand Jury at Savannah, Ga., indicted B. D. Greene, John F. Gaynor, Edward H. Gaynor, Wm. T. Gaynor, M. A. Connolly and Oberlin M. Carter on the charge of conspiring to defraud the Government, the same charge on which Capt. Carter was found guilty by court martial.

1899, Dec. 14.—Indicted parties, except Connolly, surrendered themselves in New York to U. S. Commissioner Shields, bail was accepted, and Dec. 23 set for examination.

1899, Dec. 23.—Hearing before Commissioner Shields adjourned one week by agreement of counsel. Adjournment currently reported to be to enable John F. Gaynor to take a wedding journey.

1899, Dec. 30.—Examination begun before Commissioner Shields. Adjourned to Jan. 3. Continued on Jan. 3 and 4. Adjourned on latter date to Jan. 16.

1900, Jan. 16, 17, 18, 19.—Proceedings continued before Commissioner Shields. Adjourned on last date to Jan. 24.

1900, Jan. 24.—Proceedings resumed, adjournment taken to Jan. 27.

1900, Jan. 27.—Proceedings resumed, but witnesses for defence not ready and case adjourned to Feb. 1.

1900, Feb. 1.—Examination of witnesses concluded.

1900, Feb. 2, 3.—Summing up of counsel before Commissioner Shields.

1900, Feb. 10.—Commissioner Shields decided there was "probable cause" to hold the indicted persons.

1900, Feb. 13.—Application for warrant for removal of indicted persons to Savannah made to Judge Brown, in U. S. District Court. Feb. 17 set for hearing of arguments on application.

1900, April 3.—Federal Grand Jury at Savannah made formal presentment calling attention of Congress to the delay in bringing to justice Carter's co-conspirators, and urge legislation to expedite trial of indicted persons.

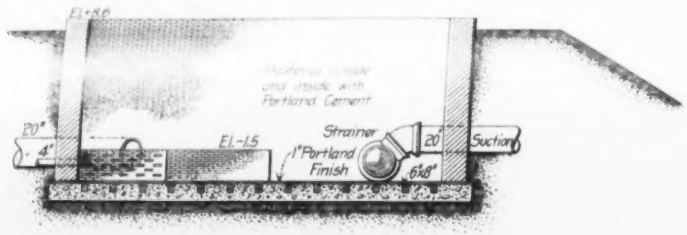
1900, April 4.—Judge Brown rendered a decision refusing to grant the warrant for the removal of the indicted persons to the Savannah jurisdiction, on the ground that Commissioner Shields erred in his rulings in the proceedings conducted before him.

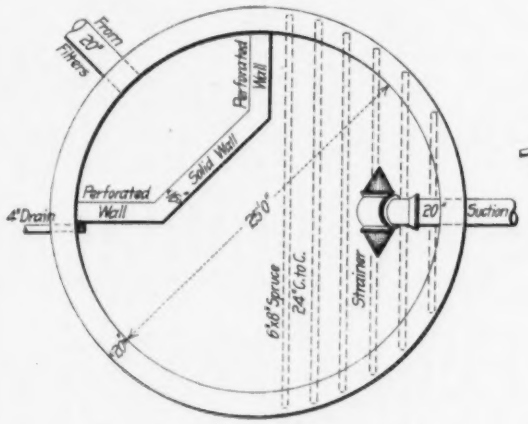
In the light of the above record, it is difficult to speak with patience of "the law's delay." The object of Carter's co-conspirators is hardly concealed. By taking advantage of every legal technicality, and injecting delay into every stage of the proceedings against them, they are so prolonging these proceedings that long before they can be tried and convicted the statute of limitations will take effect, and they can snap their fingers at courts and juries.

In the light of their evident success thus far, it is a matter for sincere congratulation to every supporter of honest government that Carter himself was tried by a military court. As matters stand, there can be little doubt that despite his attempt to get free, by appeals to the higher courts on technicalities, he will eventually have to undergo the full penalty awarded for his crime.

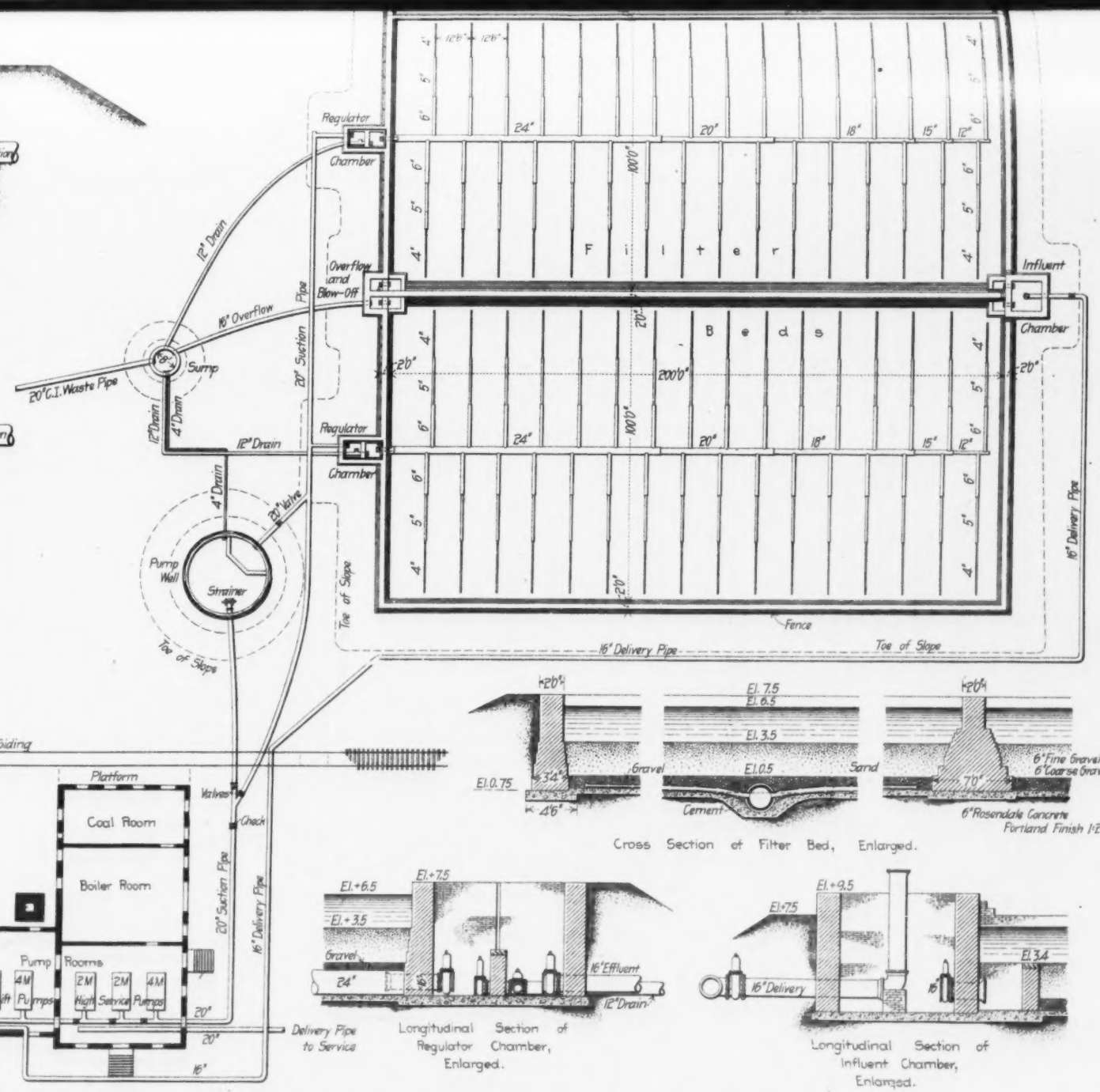
Capt. Carter was convicted, before an able and impartial court, of the crime of conspiracy. The same evidence that proved him guilty, logically, though not legally, proved guilty those who conspired with him. If they now escape all punishment for a crime thus publicly proven, what a precedent it will establish! If the United States Government is thus powerless to punish those who conspire to defraud it, those who engage in river and harbor work, the construction of public buildings or such great enterprises as the Isthmian Canal, will take notice and govern themselves accordingly. If the precedent is established that wealthy and influential contractors for pub-

*See Eng. News, April 19, 1900.





Plan and Section of Pump Well. Enlarged.



Cross Section of Filter Bed, Enlarged.

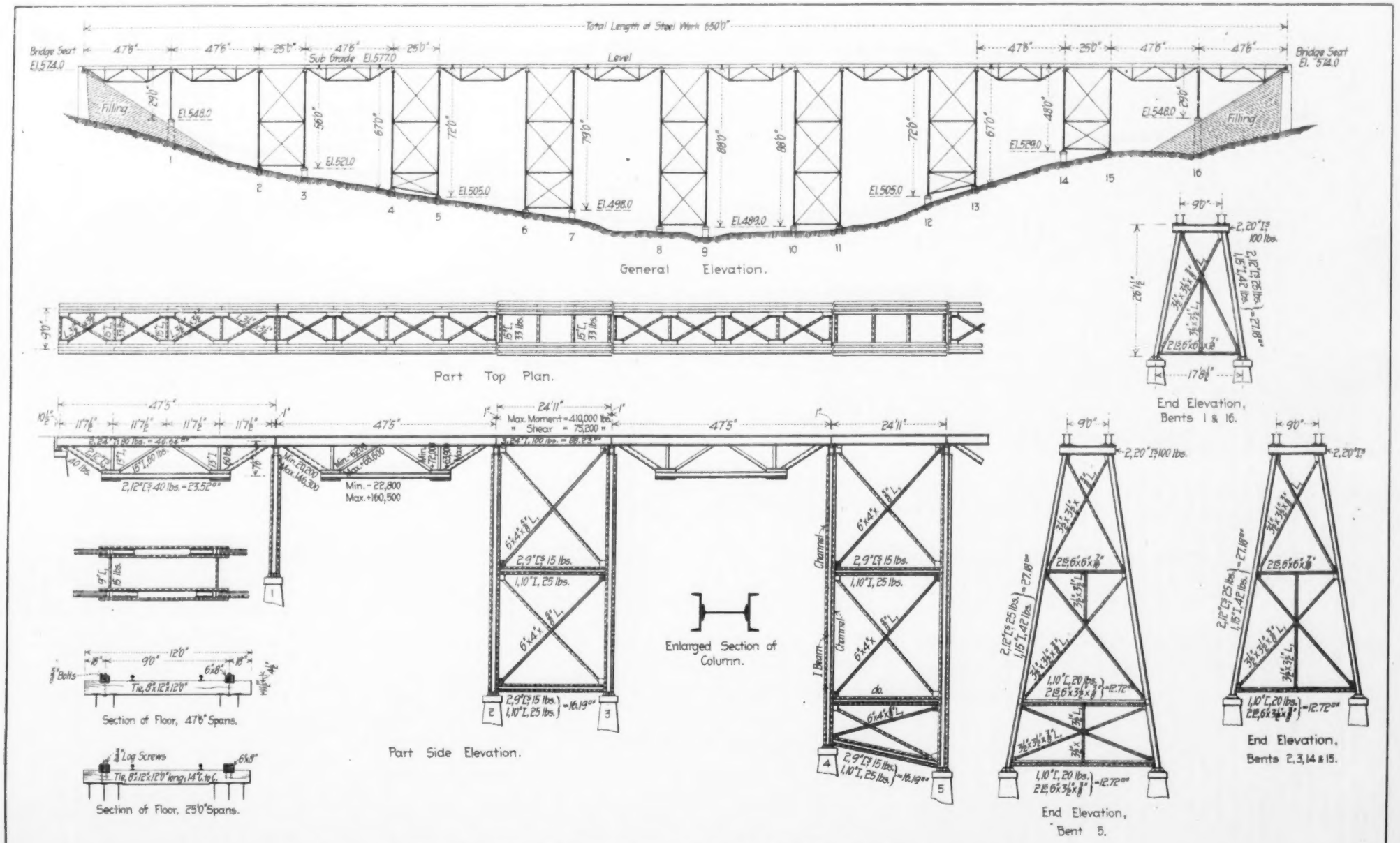
Longitudinal Section of Regulator Chamber, Enlarged.

Longitudinal Section of Influent Chamber, Enlarged.

FILTER BEDS AND PUMPING STATION OF THE QUEENS COUNTY WATER CO., FAR ROCKAWAY, N. Y.

Chas. R. Bettes, Assoc. M. Am. Soc. Engineer.

CHAS. HART, LITH., 26 VESEY ST., N. Y.



GRASSHOPPER CREEK VIADUCT; CHICAGO & EASTERN ILLINOIS R. R.

W. S. Dawley, Chief Engineer, C. & E. I. R. R. Detroit Bridge & Iron Works, Builders.

lic works can thus rob the Government and escape punishment, the way of every honest engineer and honest contractor is made more difficult.

The bill appropriating $200,000 for making surveys for the proposed 1,000-ton barge canal from Lake Erie to the Hudson River passed the New York Legislature just before its final adjournment. Its final enactment, after its defeat had been generally believed to be certain, appears to have been due to the energy and persistence of Governor Roosevelt. The bill, which had appeared to be hopelessly buried in committee, was called up in the Senate on April 5, and passed by a vote of 31 to 16. In the Assembly the bill was reported during the last hour of the session, after the hands of the clock had been turned back, and was passed by a vote of 99 to 44.

As enacted the bill provides for surveys, plans and estimates of the cost of enlarging the canal within the city of Rochester, or of passing to the north or south of that city; of enlarging and eliminating locks, of building a new canal north of Syracuse, and of utilizing the Mohawk River for part of its course. The bill further provides:

> The surveys, plans and estimates for the construction and improvement of the Erie Canal shall be for such dimensions as will give the said canal sufficient size to carry and lock through boats 150 ft. in length, 25 ft. in width and of 10 ft. draft, with a cargo capacity of approximately 1,000 tons each.

It is of interest to note that in the debate and vote upon the bill, the division was upon geographical rather than party lines. The representatives and senators from the non-canal counties strongly opposed the measure, and its chief support came from the New York and Buffalo members, without regard to party.

FUTURE POSSIBILITIES IN GAS MANUFACTURE AND DISTRIBUTION.

In commenting on the Chisholm fuel gas process in our issue of Feb. 15 last, we expressed the opinion that fuel gas made by common and well-known methods was likely to be used in the future to a far greater extent than at present. Elsewhere in this issue we publish two papers which are of much interest in this connection. One of these describes a water-gas process which has come into extensive use on the Continent of Europe, and by which over 80% of the heat energy of the fuel put into the gas generator is delivered in the gas produced. The product contains about 50% of hydrogen and 40% of carbonic oxide, and the calorific power is about 300 B. T. U. per cu. ft., or a little less than half that of illuminating gas as commonly distributed. The cost of manufacture of the gas from coke at $1.75 per ton is stated to be only 6 cts. per 1,000 cu. ft. At these figures it is almost impossible to set a limit to the uses of the gas.

Thus far its most important application has been in isolated plants for industrial works; but its general distribution in cities for light, heat and power seems certain to come about. The old obstacle to the general distribution of fuel gas, that it could not be used for illuminating purposes, has been done away with by the development of the incandescent burner; and this combination should give a light far cheaper than any in existence, and should greatly increase the use of gas for illumination. For heating and cooking, a successful low-priced fuel gas should be of almost universal application, and the consumption of gas in this manner will probably far exceed its use for illumination.

For power, the widespread use of the gas engine and the displacement by it of the steam engine in a great variety of industries depends chiefly on the successful generation and distribution of low-priced fuel gas. In the paper referred to, it is stated that a large Continental maker of gas engines is guaranteeing a consumption of only 30.5 cu. ft. of gas per horse-power hour, in his engines using this gas. Assuming a calorific power of 300 h. u. per cu. ft., this means that about 28% of the total heat energy in the gas is turned into mechanical work, as compared with perhaps 12% in the best steam engines.

These figures are certainly significant of what Mr. Geo. Westinghouse, in a recently issued pamphlet, calls "an Industrial Revolution." It will not come all at once, and there will always be many fields in which the great adaptability of the steam engine and its susceptibility of perfect control and regulation will enable it to hold its own. It is practically certain, however, that the next two decades are certain to see an enormous increase in the use of gas for power, for heating and for industrial purposes.

We have quoted above a cost of 6 cts. per 1,000 cubic ft. for the water gas made by the above-named process; and we see no reason why such figures may not be attained in the manufacture and use of such gas in industrial works. Before a low figure can be attained for gas distributed over a large area through city streets, however, a radical revolution must be brought about in the present systems of gas distribution.

Practically all gas is now made and distributed at very low pressures, only an ounce or so per sq. in., and the gas companies are all the time working on the well-nigh impossible task of keeping the pressure uniform all over their system of mains. To do this they have to make their mains so large that the friction of the gas flowing through them will be almost nothing.

With the best endeavors and with all that can be done in the way of pressure regulating devices on the mains, the pressure on different parts of the system is exceedingly variable. There is probably not a gas office in the country that has not more or less constant complaints on the one hand of low pressure and poor light, and on the other of high pressure, resulting in blowing jets and extravagant and wasteful use of gas. To add to the difficulties of the case, variations in the elevation of different parts of the system cause further variations in pressure, and deposits of moisture, etc., in the mains is a trouble against which the gas superintendent must be perpetually on his guard.

All these difficulties are inseparable from and inherent in the present system of low pressure distribution of gas. They can never be overcome, and the cost of distribution of gas must always remain much in excess of its cost of manufacture until a more rational system of gas distribution is adopted. Water is distributed at high pressure through the streets of every city in the country. Why should not gas be?

In our issue of Oct. 5, 1899, we published a paper in which Mr. F. H. Shelton, of Philadelphia, advocated this practice. He cited the experience of the gas company at Danbury, Conn., in support of his views, and reinforced his arguments by the well-known practices in the natural gas fields. Since then Mr. Shelton has shown the courage of his conviction by putting down a 3-in. line between Phoenixville and Boyersford, Pa., under 10 to 20 lbs. pressure, and closing the dilapidated gas works at the latter place, and he has described his work in a paper printed elsewhere in this issue. Manifestly, it would be but a step further to distribute the gas under increased pressure, making use of governors or reducers between the street mains and the house piping system of every consumer.

The change which such a system of distribution would effect would be enormous. Small wrought-iron pipes with tight joints would replace the present heavy and expensive cast-iron mains with their calked lead joints, always more or less liable to leakage. All the troubles with equalizing pressure throughout the distribution system would cease. As the gas is finally used at a pressure of only an inch or two of water, the variations in the pressure in the mains would be immaterial. It might be 40 lbs. at the gas works and only 5 lbs. at the end of a main several miles away during the hours of heaviest consumption, and no one would know the difference.

To the success of such a system of distribution two things alone appear to be necessary. They are the making of permanently gas tight joints on the distributing mains, and the use of an absolutely reliable pressure-reducer. We believe both these to be entirely possible. For the first, the lead-packed joint with the compression screw, so extensively used on ammonia piping, might fill the bill. As proof that the other is feasible, we may refer to the tens of thousands of railway cars in all parts of the world equipped with Pintsch gas. On every such car an automatic regulator keeps a steady pressure of about 1 inch of water or less on the car piping system, no matter whether the pressure in the gas storage tanks is 1 lb. or 200 lbs.

Finally, it may be pointed out that the reduction in the size of gas mains which would result from the adoption of such a system as we have outlined would considerably simplify the problems of underground distribution in our city streets. It might prove practicable to lay mains on opposite sides of the same street to lessen the cost of street openings and the disturbance of the pavement in making connections. If the pipes are disposed of in subways, the smaller space occupied would be a matter of importance.

The objection which has always been brought against cheap fuel gas by the advocates of existing systems is that it is too poor in quality to be economically distributed over any large area. It will be clear from the above discussion that the distribution of gas under pressure will overcome this difficulty, and that it is therefore an important element in the public use of fuel gas on a large scale.

LETTERS TO THE EDITOR.

The Power Multiplying Engine Co.

Sir: I have read in your issue of March 15 an article entitled "Concerning Certain Curiosities," which is addressed particularly to a prospectus of the Prentice Investment Co., Edison Building, 44 Broad St., New York city, exploiting the Power Multiplying Engine Co.

It seems that my name is used in said prospectus as having endorsed the merits of said alleged "multiplying engine."

I beg to confirm all that you state in your editorial relating to myself in such connection, to the effect that I repudiate such alleged endorsement of said device, and have to thank you for making known such fact. The claims made on behalf of said engine are in my opinion preposterous and I cannot believe that any reputable engineer has endorsed same. Certainly I have not done so.

Yours respectfully, W. Barnet LeVan.

Trenton, N. J., April 3, 1900.

Repairing Steel Tapes.

Sir: Noticing the articles in Engineering News, of Feb. 22 and March 1 and 8, regarding the repair of broken steel tapes, I offer a few practical suggestions as to methods which I have found very useful in this connection, for tapes from 25 ft. to 500 ft. long.

As a usual thing tapes are not broken in front of a jeweler's or a tinsmith's door. With us they break up among the mountains, at elevations of 10,000 to 13,000 ft.; and jewelers are scarce in such places. To say that breaks under such conditions are inconvenient is putting it pretty mildly. Even on street and railway work, it is frequently inconvenient to hunt up some one to repair breaks.

A method pursued by mineral surveyors to quite an extent may be described as follows: Small pieces of copper, or tin from an old tin can, are cut into strips say ⅝-in. wide, and then cut crosswise of a size that will lap around the tape to be mended and just about meet on the flat side of the tape—not the edge. These, with an ordinary candle, a piece of solder and some stick flux (both of which latter may be obtained from any electric plant), a small flat file and a pair of small nippers complete the outfit.

These may all be put into a small sack and carried in the pocket, where they are always ready, and when a tape is broken it can be repaired in the field in five minutes, thus saving time and the inconvenience of using a broken tape, or going a long distance to get it repaired.

One end of the tape can be used as a "form" about which the clasp may be bent. The tape and clasp should be brightened with the file before the clasp is bent into the proper shape. When the tape is put together, clamp the clasp tightly about the tape with the nippers; heat in the candle and put sufficient flux on to run under the clasp; then hold the solder on the splice until it has melted and run under and about the clasp; allow it to cool without movement of the ends of the tape and the work is done.

The above "outfit" does not weigh over a pound, and is all that will be needed, thus doing away with a machine shop for doing a little tape splicing. Tapes can easily be mended in the above-described manner so that they will hold all a man can pull. The stick flux mentioned above is much more convenient than a bottle of acid and zinc, as it will not break and spoil the clothes, and does the work as well as the acid.

Yours truly, C. W. Gibbs.

Telluride, Colo., March 31, 1900.

Some Recent Experiences with Tile Floors.

Sir: It may be instructive to those of your readers interested in fireproof construction to learn of some recent occurences in connection with the construction of buildings with tile floors in New York city.

At 19th St. and Fourth Ave. a building is in process of construction with 15-in. floor beams placed 6 ft. apart and filled in between with flat arches of 8-in. tile. Above the tile was placed the usual fill of lean cinder concrete. The contractors for placing this concrete found that the tile arches showed signs of failure if they rammed this concrete in the ordinary manner, so, instead of packing it with rammers, they procured a light iron roller, and after the concrete was leveled the workmen drew this roller back and forth over the surface to compact and consolidate the concrete. In this manner the construction was proceeded with until the sixth floor was reached. While a workman was moving the roller back and forth over the concrete of one of the bays on this floor, the tile arch beneath suddenly gave way for a length of 15 to 20 ft., fell to the floor below, struck the corresponding bay there, carried it down, and so on for floor after floor in succession until the whole mass, with the workman and his roller on top, brought up in the cellar.

Strangely enough, the man suffered no serious injuries by his fall of six stories, the velocity of the falling mass being somewhat checked of course at each story; but the clean sweep of the flooring in this bay from the sixth floor to the cellar was a remarkable illustration of the small resistance which tile flooring as actually placed in buildings can offer to a shock.

Another accident of a somewhat similar character occurred in a building at 38th St. and Seventh Ave., not long ago. Here a workman on the seventh floor was engaged in ramming a concrete fill on top of a 5-ft. square panel filled with tile. Suddenly the arch gave way and the whole mass fell story after story, as in the other case, until it was stopped on the second floor by striking some loose planks. The workman who went down with the mass was not so fortunate, however, as in the other case. He received very serious injuries and barely escaped with his life.

In view of such occurrences as these, it is instructive to reflect that under the present administration of the New York Building Department, tile arch construction is accepted without question, while concrete floors (except those which are backed by political influence) are rigorously turned down.

I deem it important, however, that such occurrences as the above should be brought to the attention of the engineering profession. Those outside of New York city should understand that although the architects and builders of the metropolis may specify a flower pot construction instead of artificial stone for fireproof floors, their example does not constitute a precedent which it is wise to follow.

Truly yours, G. V. M

New York, April 6, 1900.

Why Compensation Reservoirs in Lieu of Damages for Water Diversion are Permissible in Great Britain But Not in the United States.

Sir: Lawyers would probably consider the matter on pp. 228-9 of your issue of April 5, relative to compensating reservoirs and to damages for diversion of water, rather curious reading. The true explanation why British engineers commonly use compensation reservoirs, and American engineers are constantly balked of doing so, I have never seen in print. But many years ago, after taking the trouble to import a lot of Water Acts of the British Parliament and of reading them, I studied the thing out for myself.

In England, where there is no written constitution, Parliament can sit as a jury, can assess damages, and can, indeed, do anything else it has a mind to. It commonly sits as a jury in cases of water diversion and prescribes the damages to be paid; at the same time assessing these damages in the form of stored water forever to be delivered at decreed times, and in decreed quantities. In this country, no state legislature can do aught but legislate under its State Constitution; it cannot act as a judicial body (except in cases of impeachment) nor as a part of the executive; and the judiciary and the executive branches of government are similarly confined to their own proper functions and duties; "to the end," as says the Constitution of the good old Commonwealth of Massachusetts, "that this may be a government of laws, and not of men." Hence the legislature in granting rights to divert water, cannot at the same time sit as a judicial body, as in Great Britain, and assess damages and prescribe modes of paying them. Looking further, it cannot "take property without just compensation"; and it has long been decided by the highest courts, and is a settled principle, that a "just compensation" must be paid in money and cannot be paid in any other way. Every person has, further, the right of an appeal to a jury of his countrymen, to decide what amount would be a just compensation, and cannot, at some stage of the proceedings, be deprived of this his right of appeal. Here are difficulties enough to prevent the construction and operation of compensation reservoirs in payment of damages for the diversion of water in the United States.

This may at first glance seem an awkward position in which have been placed the diverters of water in the United States; because the operation of a compensation reservoir seems at first glance such a perfect form of compensation for water diverted. There is, however, a good deal to be said upon the other side, and, as usual, it is weak humanity that is at fault. The trouble comes in the course of time, on account of the difficulty of compelling the responsible parties to properly keep in repair and to operate the compensating reservoirs, year after year; and on account of the manifold changes that take place in the pecuniary and other interests of the inhabitants of any given locality in the course of time. So that, for one, I have come to the conclusion that, while the English way is the better from a scientific and theoretical standpoint, the American method is better from the standpoint of the good citizen of a republic.

It might seem that there would be cases in which a city, by obliging itself to maintain and operate certain works forever, could show that it had not damaged certain property by a water diversion, hence that there would be no damage to pay. But a jury would have to decree to that effect; a riparian owner has the right to have the water flow by him without "alteration"; and many other such lions lie in that path.

Your article also touches upon the everlasting question of the amounts to be paid for the diversion of water, when paid for in money; but that is too large a subject to discuss here with any fullness. That the damage is arrived at by subtracting the market value before and after the diversion, the one from the other, is an old and the fundamental principle; but the difficulties become mountain high, just so soon as the parties begin to contend as to what figures shall constitute the minuend and the subtrahend in that enticing equation.

2 Wall Street.

2 Wall St., New York, April 6, 1900.

Diagram Showing Safe Load on Columns According to the New York Building Code.

Sir: The accompanying diagram shows the safe load on steel columns and struts with flat ends, where they are calculated according to the requirements of the building code of New York city, adopted Oct. 10, 1899. While the

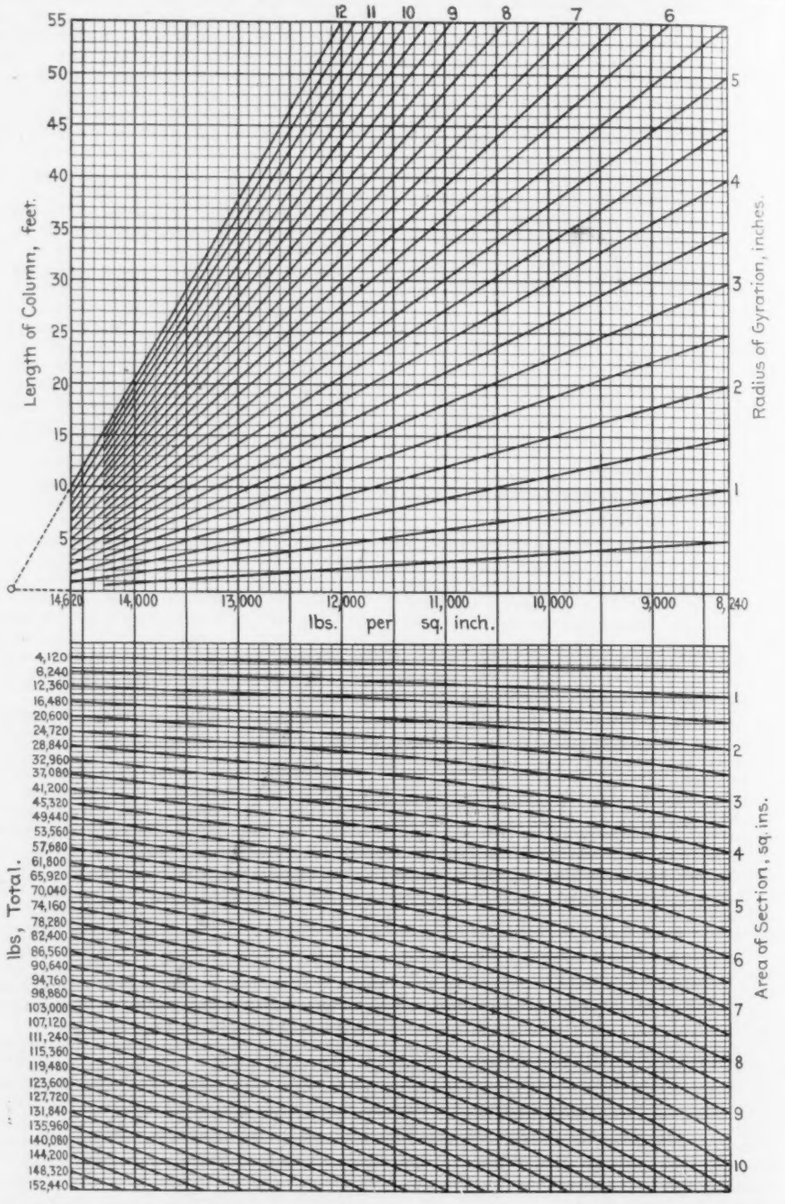


DIAGRAM SHOWING SAFE LOAD ON COLUMNS CALCULATED ACCORDING TO THE NEW YORK BUILDING CODE.

diagram was primarily intended for publication in connection with other matters, it may be of interest to your New York readers at least, since it is simplicity itself, and will save labor in any office that has to design to conform to the New York building code.

The explanation of the diagram is as follows: The equation for the unit load per sq. in. is:

$$W = 15{,}200 - 58\,(l - r).$$

W = load in lbs. per sq. in.
l = length of column in inches.
r = radius of gyration in inches.

Find the radius of gyration corresponding to the proposed section on the right-hand or upper side of the diagram (if radius is not an even inch or half-inch inter-

polate with a ruler); follow the radial line, representing the radius of gyration, until it intersects the length of the column, which is noted on the left-hand side of the diagram, then follow the vertical intersection-line to the foot of the upper diagram, where the allowable load per square inch will be found noted in pounds. Take, for instance, the 16-in. Z-bar column in Carnegie Pocket Companion of 1896, which has four Z-bars 6⅛ ins. × ⅞-in. and one web 10 ins. × 1 in., and two side plates 16 ins. × ½-in. This column has a radius of 4.5 ins. Now follow the radial line at 4.5 until it intersects the first heavy horizontal line below, which represents 40′. This intersection occurs a little to the left of the vertical line representing 9,000 lbs., and we conclude that it reads 9,020 lbs. Solving by the column formula the exact value will be found to be 9,018 lbs. To find the total carrying capacity of our columns, which has 66.7 sq.ins., follow the 9,000-lb. line on the lower diagram until it intersects the horizontal line representing 6.5 sq. ins., which is noted on the right-hand side of the lower diagram.

We find that at 6.4 sq. ins. a curve intersects, which, followed to the left of the diagram, reads 57,680 lbs.

However, our area was 6.6, so we must interpolate for 0.2 sq. ins. By close inspection .6 will be found nearly midway between the two adjoining curves. Now remembering that the distance between two consecutive curves represents 4,120 lbs., which figure is noted at the top of the column marked "lbs. total," we judge the value to be 1,850. Adding the two numbers and multiplying by 10, as we took the value for 6.6 sq. ins., instead of 66 sq. ins., we get 595,300. For the remaining .7 sq. in. we look at the top of the lower diagram and interpolate in the same manner 6,000, which makes a total of 601,300. By actual calculation the column will be found good for 601,600 lbs. As there is a difference of only 300 lbs., the result by diagram may be considered close enough for all practical purposes.

Again, suppose it is required to design a column 16 ft. long to carry 700,000 lbs., and that the designer wishes to use a unit load of 13,500 lbs. per sq. in. of section. Follow the curve marked 70,040 until it intersects the vertical representing 13,500 lbs. This intersection takes place about two divisions below the heavy line representing 5 sq. ins. The requisite area of the column is, therefore, 52 sq. ins., or, to be exact, 51.85 sq. ins. Following the 13,500-lb. line until it intersects the 16-ft. length of column, we find that the radius must be at least 6.5 ins.

The upper diagram illustrates very plainly the requirement of the building code, that "no column may exceed 120 radii." For instnace,. a 50-ft. column must have at least a radius of 5 ins., and a 40-ft. column one of 4 ins., etc. The lower diagram is in reality a multiplication table, and can, of course, be used within its limits as a slide rule.

If any of your readers desire the diagram on a larger scale for office use, the writer can supply at cost blueprint copies on about three times the scale of the accompanying engraving. Yours truly,

A. Samuel Berquist.

108 Wilson St., Brooklyn, N. Y., March 21, 1900.

Laying Out Transition Curves.

Sir: After all that has been written on the subject of spiral transition and easement curves, it seems almost superfluous to refer to the matter again. While, however, the best engineers and mathematicians agree in theory, nevertheless, there seems to be no uniform practice in the application of the principles.

The transition spiral is a curve whose degree of curve increases directly as the distance along the curve from the point of curvature. If the circular curve is long enought to admit of it, the spiral should have a length

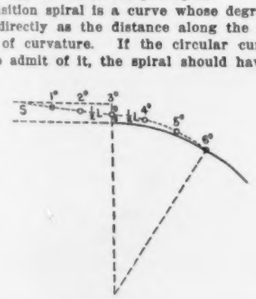


Fig. 1.

corresponding to 50 ft. for each degree of main curve. Thus, for a 6° curve the spiral would be 300 ft. in length. The relative positions of tangent and main curve is as shown in Fig. 1.

The offset and spiral mutually bisect each other. In other words $0 = 0$, and $\frac{1}{2} L = \frac{1}{2} L$. After assuming the length L of spiral, the offset, S, may be found by any of the following formulas:

$$S = \frac{L^2}{24\ R}. \quad \text{(Rankine.)} \qquad (1)$$

$$S = \frac{7\ n^2\ D^\circ}{24}. \quad \text{(Muenscher.)} \qquad (2)$$

$$S = \frac{c^2}{6\ R}. \quad \text{Exact.} \qquad (3)$$

$$S = \frac{\text{Vers. } 1^\circ \times R}{5}. \quad \text{Exact.} \qquad (4)$$

in which

S = offset.
L = length of spiral.
D° = degree of curve.
R = radius.
c = chords.
n = length of curve in chords of 100 ft.
I° = angle of spiral.

To get the tangent distances, or the distance from the apex to the point S, we have

$$T_1 = \tan \tfrac{1}{2} \triangle^\circ\ (R + S) + \tfrac{1}{2} L. \qquad (5)$$

The spiral may be run in by offsets or by deflection angles. It is more satisfactory to do the work with the transit, making use of the following simple formula:

$$\text{Deflection in minutes} = \frac{10\ D^\circ\ n^2}{L}. \quad \text{(Original.)} \qquad (6)$$

Example: Given the intersection $\triangle^\circ = 80^\circ$ between two tangents to put in a 6° curve with a spiral on each end 300 ft. long—By formula (1) we get

$$S = \frac{(300)^2}{24 \times 955.4} = 3.9;$$

by formula (5) we have

Tang. dist. = tan 40° (955.4 + 3.9) + 150 = 954.9.

The length of curve between the spirals is 1,033.3 ft.

We will assume that the station of the P. I. is 19 + 50.9; then the S will be 9 + 96; L will be 12 + 96, second L, 23 + 29.3; S, 26 + 29.3.

Table of Deflections.

For First Spiral. (Instrument at S.)		For Second Spiral. (Instrument at S.)	
S = 9 + 96	= 0° 00′	S = 26 + 29.3	= 0° 00′
10 + 50	= 0° 06′	26	= 0° 02′
11	= 0° 21½′	+ 50	= 0° 12½′
+ 50	= 0° 47½′	25	= 0° 33½′
12	= 1° 23′	+ 50	= 1° 04′
+ 50	= 2° 09′	24	= 1° 45′
L = + 96	= 3° 00′	+ 50	= 2° 36′
		L = 23 + 29.3	= 3° 00′

The rest of the curve can now be run in in the usual way. On sharp curves it is desirable to run in the entire circular curve from P. C. to P. T., and then run in the spiral afterwards.

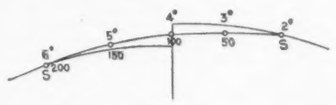


Fig. 2.

In case the station stakes are not required (as in running track centers) a simpler method may be employed for getting the deflections. With the instrument at S, the deflection for L is ⅓ the deflection for the same distance on the main curve. Thus for a 6° curve the deflection would be 3°.

The deflections are also as the squares of the distances from S. So the deflections for every 50 ft. would be as follows: Dividing the length L into 6 equal parts, we have

$$3^\circ = 180' \frac{180'}{6^2} = 5'.$$

TABLE I.

0 ft.	= 0° 00′		200 ft.	= 1° 20′	16 × 5
50 "	= 0° 05′	1 × 5	250 "	= 2° 05′	25 × 5
100 "	= 0° 20′	4 × 5	300 "	= 3° 00′	36 × 5
150 "	= 0° 45′	9 × 5			

To get in the tangent at L in order to proceed with the main curve, sight to S and turn ⅔ the angle I of the spiral —in a 6° curve it would be ⅔ of 9° or 6°; for an 8° curve it would be ⅔ + 16°, or 10° 40′, assuming a change of 50′ per degree, according to rule.

In the application to compound curves, the transition curve to connect two curves D° and $D°_1$ is practically identical with a curve whose degree is equal to the difference between the degrees of the two curves (D° — D)°.

Example: Let it be required to connect a 2° and 6° curve with a spiral 200 ft. long. Then $D°_1 - D° = 4°$; S = 1.16; we have for deflections:

With instrument at S.

0 ft. = 0° 00′.
50 " = 30′ + 05′ = 35′.
100 " = 1° + 20′ = 1° 20′.
150 " = 1° 30′ + 45′ = 2° 15′.
200 " = 2° 00′ + 1° 20′ = 3° 20′.

With instrument at S′.

0 ft. = 0 00′.
50 " = 1° 30′ — 05′ = 1° 25′.
100 " = 3° 00′ — 20′ = 2° 40′.
150 " = 4° 30′ — 45′ = 3° 45′.
200 " = 6° 00′ — 1° 20′ = 4° 40′.

Note.—When the circular curve exceeds a 6°, there is a minus correction to be applied to the tangent distances as follows: 6° — 0.1 ft.; 7° — 0.3 ft.; 8° — 0.6 ft.; 9° — 1.1 ft.; 10° — 1.7 ft..—Spaulding.

Prof. Fred. R. Spaulding, of Cornell University, has published a very valuable paper on the location of the cubic parabola, to which the reader is referred. It is published in the "Engineers' Field Book" edited by Geo. H. Frost.

The late A. M. Wellington has written some suggestions on the subject which may be found in "Railway Track and Track Work," by Tratman. Yours truly,

W. H. Sadler, C. E.,
Assistant Engineer, Delaware & Hudson Co.

Newport, Pa., March 6, 1900.

The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston, Mass.

Sir: Regarding the Scherzer rolling bridge described in Engineering News of March 15, it is true that this bridge is an interesting structure, as you say, and, although not being an engineer (stationary or otherwise), I felt a certain curiosity concerning it. No doubt the bridge is satisfactory to all concerned, but even a layman such as "the author" (as Engineer Waddell says) cannot always accept the opinion of erection foremen, that because a structure can be got in usable condition with more or less trouble, it is therefore O. K. Therefore I wish to make a few remarks (which is permissible in a free and constitutional country) and ask some questions (which any fool can do):

My first remark concerns your statement: "A heavy counterweight on each truss greatly reduces the actual load to be overcome by the operating machinery." There is no doubt but that you kept within the truth there. But "great Scott!" Why should not the structure be so proportioned as to place the center of gravity of each rolling truss (inclusive of its portion of the floor system) in the center of the segmental circle? If this were done, then, exclusive of wind, the machinery would only have to overcome the rolling friction, which, in this case, would not deserve any consideration. No doubt that the bridge was so figured by the able man who designed it; but my question is, Do the two centers actually coincide, or is the load on the machinery, as you say, greatly reduced?

Passing to your statement of conditions for calculations, it is pleasing to note that the three support truss was figured "with regard to the length and sectional areas of all members of the truss." The theory of elasticity affords facilities for checking up all the stresses of a statically indeterminate structure when we know the length and sectional area of each member of the structure. This was no doubt done in this case, as is proper in an important bridge. I would recommend to university professors the stress table given by you as a splendid opportunity for exercise. An actual structure is always more pleasing than a fictitious one. The assumption that no bearing moves vertically under loading is not a wise one. Truss "A" should have been figured for a certain variation (liable to occur) in the height of the supports, as the screw in the middle support is certain, at some time or another, to be out of level. Dead load stresses appear to have been figured for bridge closed, half open and open, which probably is ample. I fail to see any statement regarding the wind pressure, for which the machinery was figured, or, if the bridge was not properly balanced, how "greatly the actual load was reduced." The brake shown no doubt is calculated strong enough to hold the bridge in any position during a gale, but, as the brake cannot act all the time during opening or closing, the torque of the motor, no doubt, will overcome reasonable wind stresses or the "greatly reduced load."

There are lots of questions the average ignoramus feels tempted to ask. Thus, in the rolling segment or imaginary member 20 there ought to be a pretty mess of stresses. It seems as if the segment ought to be figured (1) as a straight compression member for the counterweight, (2) as a girder, (3) as a roller. In addition there must be considerable bending sideways, in the segments, due to wind loads, because there cannot be any bracing between them, as they are below the clearance line. Therefore it would be interesting to know how the sections and the rivet spacing were determined. Although you do not show it, there is probably some lateral bracing or stiffening between the counterweight boxes, but ultimately wind loads must be taken by the transverse strength of the segments.

The operating strut seems, from your Fig. 1, to have been placed nearer truss "A," or probably in the center of gravity between the trusses.

Regarding small details, your drawings do not show enough for a minute criticism. Glancing over your Fig. 2, it seems as if the bottom lateral connections were not entirely satisfactory. There may also be doubts if the ⅝-in. gusset pl., joining members 14, 15, 17 to the segment is proportional to said members. Also, if not explicitly shown, adequate provisions for expansion of the track girders and approaches are doubtless made.

Yours truly, Chas. E. Smith.

Chicago, Ill., March 18, 1900.

In accordance with our usual practice, we submitted a copy of this letter to the Scherzer Rolling Lift Bridge Co., which has replied as follows:

Sir: Replying to the above letter, signed "Chas. E. Smith," we beg leave to say:

(1) The center of gravity of the rolling bridge is in a vertical line below the center of the rolling segment when the bridge is half open. Thus gravity accelerates the velocity of the bridge during the first half of the motion, and retards it during the second half, during the process

of opening as well as during the process of closing. Gravity assists the motor to start the bridge at the beginning of the movement, and assists the brake to stop the bridge at the end.

(2) The assumptions made for the calculation of stresses in truss A, are those generally made in similar cases, and they were satisfactory to the parties interested. No doubt other parties may prefer other assumptions, but this is a matter of judgment and opinions may differ.

(3) The machinery was proportioned for a wind pressure which would be prohibitive to all navigation. The proper amount of wind pressure to be assumed for the best results in this case, was ascertained only after a number of years of experience, and we do not desire to disclose this information at this time.

(4) Member 20 was proportioned as a compression member, as a girder, as a roller, and for a wind pressure at right angles to the tracks when the bridge is in motion. The sections and rivet spacing of this member were determined in accordance with observations made upon our bridges in operation for a number of years, together with our experience. This information we must also decline to disclose at this time.

(5) There is a portal brace between the counterweight boxes and rolling segments, a few inches above the rail when the bridge is open. This portal brace is visible in Fig. 15. There are also two sets of lateral braces between the counterweight boxes and the trusses to member 17. These braces are shown in the plan, Fig. 1. They are horizontal when the bridge is closed, and are connected to each other by a vertical lattice girder between the trusses, in order to secure increased stiffness. This girder is shown in the elevation, Fig. 1.

(6) The center line of the operating strut is not exactly in the vertical plane of the center of gravity of the bridge, parallel to the trusses. Wind pressure, as well as gravity, was considered in determining the location of the operating strut.

(7) As to the ⅝-in. gusset plates connecting members 14, 15 and 17 to the segment member 20, we desire to state that member 17 is connected directly to the segment and transmits only dead load stress to the segment when the bridge is moving. Member 14 has an abutting joint and member 15 produces a sheer in the ⅛-in. gusset plates, amounting to less than 7,500 lbs. per sq. in., allowed by the specifications of the N. Y., N. H. & H. R. R. R. Co.

(8) Ample provisions, in accordance with the controlling specifications, have been made for expansion of all track girders and approaches.

Although our bridges are giving perfect satisfaction to all parties using them, we know that they can be improved, and we very much appreciate any suggestions in this direction. Yours very truly,

The Scherzer Rolling Lift Bridge Co.,
By Albert H. Scherzer,
President.

1616 Monadnock Block, Chicago, Ill., March 24, 1900.

Should Taxes Be Included With Operating Expenses in Railway Accounting?

Sir: At the risk of seeming insistent, may I be permitted a word in respect to your comments on my letter which you so kindly published on March 31? You seem to hold, with others, that the inclusion of taxes in operating expenses would make it more difficult for the owners or managers of railways to contrast the reports of several companies for the same period, or the reports of the same company for different years.

Do not differences in rates, in the volume, character and direction of traffic, in grades and curves, in climate and soil preclude such comparisons between the several railways? And, in like manner, do not changes from year to year in the crops harvested, in commercial conditions and in prices of material make such comparisons, even on the same railway, of little value as tests of the "enterprise, good judgment and economy" of the managers?

Confining the inquiry to the cost of material, in which there has, of late, been so great an increase, and considering only the single item of fuel for locomotives, we find that, in the year which ended June 30, 1898, the railways of the United States spent, on this alone, $72,469,777, or 5.81% of their gross revenue, as against $43,828,224 paid by them as taxes. The reports for the same year of two large companies, whose railways terminate at the same seaport, are before me. To one of them the cost of fuel for locomotives was 4.36 cts. per mile run, and to the other it was 16.25 cts., and yet the ratio of operating expenses to gross receipts was decidedly smaller on the latter.

Again, the report of the Railroad Commissioners of Iowa, for 1898 (p. 177), shows that the cost per ton of coal to the various railways of that state, ranged from 87 cts. on the Wabash to $3.60 on the Sioux City & Northern. On the Chicago, Burlington & Quincy it was $1.34; on the Chicago & Northwestern, $1.69; on the Chicago, Rock Island & Pacific, $1.50, and on the Dubuque & Sioux City, 89 cts. We here find in the same state and among four railways competing for the same business, variations far exceeding any that can exist in the taxes paid by them.

While it cannot be doubted that in the adjustment of taxes there is as much necessity for the use of experience, tact and good judgment, as in the disbursement of any equal proportion (3.51%) of the gross revenue, I cannot help thinking that taxes form but one of many "fairly constant charges," which in a certain sense "no vigilance or economy of operating officials can affect." The rate of wages paid to employes and the price of materials are equally beyond their control. Although good managers may save largely in the number and kind of men employed and in the amount and character of material bought, they are powerless to affect their price. Legal expenses, and especially the very considerable part of them comprised in the absolutely fixed salaries of the lawyers permanently retained, are entirely beyond the control of the operating officers, and, to a large extent, beyond that of the management itself. So also are claims and damages from the moment that the suits brought for them are tried and submitted. And yet these items, and others, such as rent of tracks and terminals, and insurance, are included in operating expenses.

While agreeing with you entirely that "one of the most important things for railway owners and managers to know is the degree of enterprise, good judgment and economy with which their property is being administered, as indicated, first, by the total receipts, and second, by the total expenditures incurred in carrying on the company's business of manufacturing and selling transportation," I fail to see why taxes should alone be excluded from statements purporting to show the cost of selling transportation. No bank omits taxes from its statement of expenses, nor would it give credit to a merchant or manufacturer who did. Nor is this course followed by the railway companies of any other country.

This way of dealing with taxes is merely a last survival of the bad bookkeeping which, in years gone by, wrecked so many of our railways. The old Baltimore & Ohio company's $40,000,000 surplus of bookkeeping assets, and the old Atchison company's $7,000,000 of Auditor's suspended balances were worked up by just such self-deceptive devices. We can all remember railway reports from which such items as Insurance and Exchange were omitted. Why not also omit the salaries of general officers, or any other item?

Nor is it correct to assume that taxes do not vary with the volume of business, and particularly the gross revenue from traffic. In Wisconsin, and presumably in other states, taxes are a certain fixed percentage of the annual gross receipts of the several railways. In every state of which I have knowledge, the gross receipts enter largely into the calculations of the boards which assess taxes on railways. The Federal war tax is levied at precisely 1 ct. on each bill of lading.

The foregoing is reasoned entirely from the point of view which you selected, of the owners and managers of railways. We are fully agreed in that, as you say, from the standpoint of the owners, taxes, being like wages, repairs and other expenditures for operation and maintenance, paid out of gross income, should therefore be classed with such expenditures.

Admitting, for the sake of the argument, that there may be reasons, in particular instances, why, from the standpoint of the managers, or the operating officers, taxes should not be so classed, let us see how the case stands in respect to the reports of the Interstate Commerce Commission and other kindred public bodies in the several states:

The Act to Regulate Commerce, by which the Interstate Commerce Commission was created, in terms applies to "common carriers engaged in the transportation of passengers or property" by railway. The Common Law requires the charges of common carriers to be reasonable. Apart from the value of the service, the reasonableness of those charges can only be determined by deducting from them the cost of rendering the service. Taxes of necessity form part of that cost, and should, therefore, be included in all statements made by the railway companies to the Commission, or by it reported to Congress. This is made the more obvious by the further provision of the statute, which requires that the reports made by the Commission to Congress "shall contain such information and data collected by the Commission as may be considered of value in the determination of questions connected with the regulation of commerce."

As those reports contain the only information which reaches Congress as to the cost, to the railways of the United States, of rendering service as common carriers, it is essential that they show it plainly and in full. The exclusion by the Commission of taxes from their statement of the expenses of operation of the railways of the United States, for the year 1898, resulted in those expenses being understated by $43,828,224.

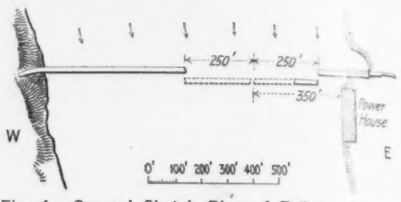


Fig. 1.—General Sketch Plan of Failure of Austin Dam.

(Prepared from telegraphic report of Prof. T. U. Taylor, Assoc. M. Am. Soc. C. E.)

In view of the requirements of both the common and the statute laws, I have faith to believe that you and others will agree with me in thinking that, in the reports of the Commission at least, taxes should be included under operating expenses. The magnitude and the constancy of the error, over forty millions of dollars annually, form my excuse for troubling you further on this subject. Truly yours,

Stuyvesant Fish.

214 Broadway, New York, April 3, 1900.

Notes and Queries.

C. J. J. asks: Can you or any of your readers give the present address of Mr. Fred. H. Pickles, formerly City Engineer of Winona, Minn.?

In describing the laying of the 36-in. water-main under the Harlem River, in our issue of March 22, Mr. E. R. Lowe was erroneously referred to as the contractor for the work. Mr. Wm. H. Masterson, of Park Ave., Borough of the Bronx, had the contract for laying the whole line of 36-in. main, and Mr. Lowe was in charge of only the work described.

FAILURE OF THE GREAT MASONRY DAM ACROSS THE COLORADO RIVER AT AUSTIN, TEX.

On April 7 a great flood in the Colorado River swept out a portion of the masonry dam owned by the city of Austin, Tex., ruined the power house and did much other damage, including the cutting off of the city from its water and electric lighting supplies, and (we suppose) depriving all or some of the street system of electric power. Pending a full account of the failure of the dam, we secured a telegraphic summary, from Mr. T. U. Taylor, Assoc. M. Am. Soc. C. E., Professor of Civil Engineering, University of Texas, Austin, Tex., as follows:

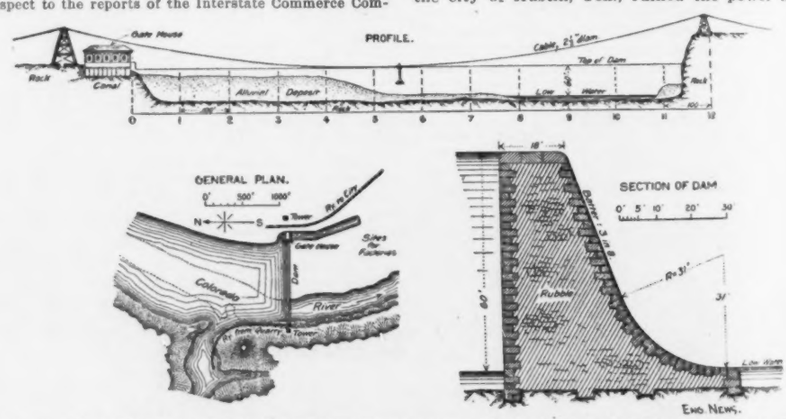
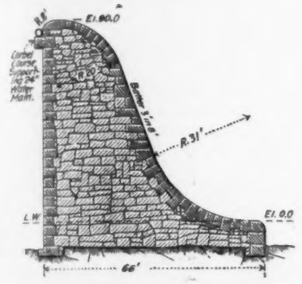


FIG. 2.—PLAN, PROFILE AND CROSS-SECTION OF AUSTIN DAM, AS ORIGINALLY DESIGNED.
J. P. Frizell, M. Am. Soc. C. E., Engineer; John Bogart, M. Am. Soc. C. E., Consulting Engineer.
(Reproduced from Engineering News, July 11, 1891.)

Five inches of rain fell along Colorado River from after-

noon Friday to 4 a. m. Saturday. By 11 a. m. Saturday lake was 11 ft. above dam crest; at 11:15 dam parted 350 ft. from east end and two sections, each 250 ft. long, were shoved 40 ft. down stream and rested parallel to dam. Forty minutes later west half at broken part broke and disappeared, likewise 150 ft. of eastern half. This left 100 ft. of dam at east end and 500 ft. at west end unharmed and nearly half of dam washed away. There was no overturning, but a lift up and shove down stream. Indications are that little of the foundation remains.

At first break flood rushed against wall of power house, crushed windows and drowned eight people in lower stories. At 12:05 Saturday night, two-thirds of west wall of power house fell in, bringing down roof over dynamo room and injuring machinery. Total damage not less than $250,000. Original cost of dam over $500,000; power house, $50,000; total bonded debt for water and lights over $1,500,000.



(Reproduced from Engineering News, Aug. 29, 1894.)

Fig. 3.—Section of Dam as Built.

J. T. Fanning, M. Am. Soc. C. E., Consulting Engineer.

The water and light commission resolved on April 9 to provide a steam plant for temporary purposes and to take steps immediately to rebuild the dam and power house upon securer plans and to provide against leaks in headgate masonry. The co-operation of the bondholders will be asked. Thos. U. Taylor.

From the description just given, we have prepared a sketch, Fig. 1, showing the location of the break. We have also reproduced a number of illustrations from previous issues of Engineering News, designed to be possible, aids to a full understanding of the failure. Fig. 2 shows the original design of the dam; Fig. 3, the modified cross-section; Fig. 4, the masonry bulkhead, the penstocks and power house, the penstocks having been substituted for the hydraulic canal originally proposed, shown in Fig. 2, and the location of the power house having been changed accordingly; Fig. 5 shows the location of the dam in relation to the city, and also the lake formed by it.

This lake covered over 1,800 acres, and was 20 to 25 miles long. The Colorado River above Austin has a drainage area of about 40,000 sq. miles.

A preliminary report on the proposed dam was made in March, 1890, by Mr. Jos. P. Frizell, M. Am. Soc. C. E., supplemented by a report by Mr. John Bogart, M. Am. Soc. C. E., as consulting engineer. Mr. Frizell was chosen Chief Engineer, and ordered to prepare complete plans. The contract for the dam having been let previously to Mr. Bernard Corrigan, of Kansas City, Mo., excavation was begun at the site of the power house on Oct. 15, 1890. The first masonry in the dam was laid on May 5, 1891, and the last stone was set on May 2, 1893, and the reservoir was filled so that water flowed over the crest of the dam in the same month.

Mr. Frizell did not continue as chief engineer of the dam until its completion. According to the report (1891-2) of Mr. J. W. Oliphant, Secretary of the Board of Public Works, early in 1892 "a serious difference of opinion concerning the best method of utilizing the water power created by the dam, and the proper location of the power house, arose between some of the members of the board and Mr. J. P. Frizell, the chief engineer." Mr. Frizell proposed (Fig. 2) to locate the power house on the bank of the river, 600 ft. below the dam (on "alluvial soil," the report says), and to build a canal half-way from the east end of the dam to the power house, conveying water the balance of the distance in iron penstocks. Some of the members of the board favored using penstocks only, the power house to be built "on the rock ledge below the dam, where it could not be damaged by high water." In January, 1892, Mr. E. Geyelin, of Philadelphia, was called on for advice. He visited Austin in February and reported in favor of the contentions of the board, recommending that the power house be placed "on the solid rock about 100 ft. down stream from the east end of the dam." He also advised that the force main be laid on headers, or corbels, thus extending across the dam, as shown in the section, Fig. 3. This report was adopted, but subsequently Mr. Frizell made a strong report in favor of his original plans, and also in favor of laying the force main in the bed of the river below the dam.

At this juncture the board engaged Mr. J. T. Fanning, M. Am. Soc. C. E., to report on the work in hand. On June 24, Mr. Fanning made an extended report on the whole scheme, including the

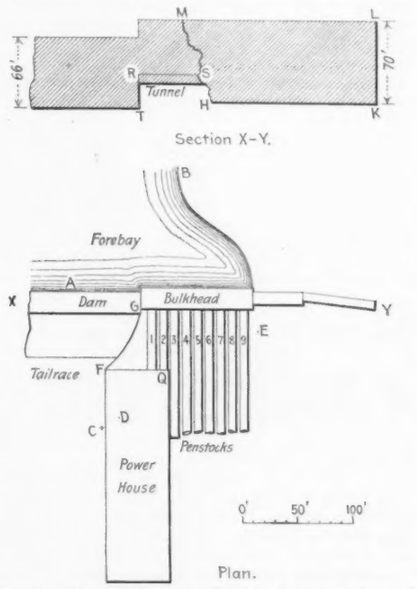


Fig. 4.—Plan of Masonry Bulkhead, Penstocks and Power House, Showing Location of Various Leaks.

(Reproduced from Engineering News, Feb. 22, 1900.)

proposed water-works and lighting plant, for which the power was being developed (see Eng. News, Aug. 18, 1892).*

Mr. Fanning approved the changes urged by the board, as recommended and modified or extended by Mr. Geyelin, but proposed that the power house should be built on the solid rock close to, instead of 100 ft. below, the east end of the dam.

According to Mr. Oliphant's report, the board had differed from Mr. Frizell regarding "the proper form of the down-stream part of the top of the dam," the plans showing a flat crest (see Fig. 2), but "some fears were expressed that the foundation would be endangered by the falling of heavy masses of water beyond the toe of the dam during great floods in the river." This question being referred to Mr. Fanning, the report states, he recommended a change to the form of crest shown by Fig. 3. Mr. Fanning's report "was adopted by the unanimous vote of the board, which action was subsequently ratified by the city council." Mr. Fanning was retained as consulting engineer, "and requested to complete the plans for the works recommended in his report." About this time Mr. Frizell's resignation as chief engineer to the board was accepted, to take effect on June 30, 1892. Mr. E. W. Groves was placed in charge of the construction of the dam, and Mr. N. Werenskold in charge of the settling reservoir and distribution system.

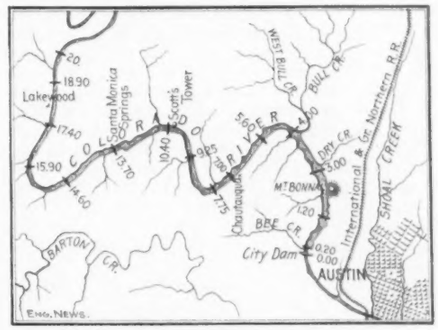


Fig. 5.—Map of Lake McDonald, Formed by Austin Dam.

(Lines and figures indicate distance, in miles, from dam. —Reproduced from Engineering News, Feb. 22, 1900.)

Mr. Fanning stated in his report that no high dam in existence was called on to pass so great a flood (200,000 to 250,000 cu. ft. per sec.), as might be expected at Austin, and expressed fears that the blow from the falling water would erode the soft rock at the toe just below the dam. The section shown in Fig. 3 was recommended as being better adapted to pass the flood in a gliding sheet down the face of the dam, and to deliver it to the lower level without a direct blow, and so that its velocity will be expended chiefly in a horizontal direction in the backwater below the dam, and in eddies at a safe distance below the toe of the dam.

In our issue of Sept. 29, 1892, we published two articles by Mr. Frizell, one general, on the flow of water over wide, level-topped weirs, and another dealing directly with Mr. Fanning's report. The articles showed that the author had given much careful thought to the proper section for the top of the dam, and advanced his reasons for adopting a flat crest. One of the chief reasons was the fact that with the flat crest flash boards might be used; and another was his disbelief that a rounded crest would have any appreciable effect on the possible damage wrought by a flood. He pointed out that there would be no danger from ice and saw logs, although the river carries large quantities of drift wood. He also urged that it was impossible for the flood flow of the river, assumed by Mr. Fanning as 15 ft. on the crest, to fall clear of the whole dam and strike the river bottom below the toe, since with 15 ft. of water on the crest there would be 45 ft. of water in the river below the dam. In short, he had little fear of damage to the rock below, in time of floods, partly because floods were of such short duration at that point, and suggested that, on their subsidence:

The bottom could be inspected, incipient abrasion detected, remedial measures executed. A bed of Portland cement concrete, 10 yds. wide, 100 yds. long, 1 yd. deep, could be put in for $6,000. There is no probability that such a measure would be called for more than once in five years. The power to hold 8 or 10 ft. of water above the normal level of the lake, a power destroyed by the rounding of the dam, would ultimately be worth to the enterprise $25,000 to $50,000 a year.

The report by Mr. Fanning, and the two articles

*We give here references to the various articles on the Austin dam and allied subjects which have appeared in Engineering News since the dam was started; asterisks after the date mean that the article in question is illustrated:

General description of dam, prepared from information sent by J. P. Frizell, July 11, 1891.*

Lidgerwood Suspension Hoisting Cableway, Nov. 14, 1891,* and April 9, 1892.

Report by J. T. Fanning to Board of Public Works, recommending substitution of penstocks for hydraulic canal, changes in location of power house, in section of dam and in location of force main, Aug. 18, 1892.*

Discussion of flow of water over dams with wide, horizontal tops and with top curved down stream, by Messrs. J. P. Frizell, Sept. 29, 1892;* Clemens Herschel and Prof. L. G. Carpenter, Nov. 10, 1892,* and C. W. Hodson, Dec. 22, 1892.*

The so-called engineering ethics of the changes recommended in design of the work, article by J. P. Frizell, and editorial note, Sept. 29, 1892;* letters by "M. Am. Soc. C. E.," and Messrs. Fanning and Frizell, Dec. 15, 1892. Joint open letter by Thos. Doane, M. M. Tidd and Clemens Herschel, demanding investigation by Directors Am. Soc. C. E., and editorial note, Jan. 12, 1893;* letters by J. P. Frizell and N. Werinskold, Feb. 23, 1893.

Article describing dam and progress to date, by E. W. Groves, Engineer-in-Charge; long reprint from report of J. W. Oliphant, Secretary Board of Public Works, outlining controversy between the board and Mr. Frizell, and the cailing in of Messrs. E. Geyelin, followed by J. T. Fanning; also account of progress to date, Jan 26, 1893.*

Partial failure of headgate masonry and accompanying leaks, press despatch accounts, June 8 and 29, 1893, the latter including report of J. T. Fanning on the failure; also July 27,* Aug. 3 and Sept. 28, 1893, the latter including another report by Mr. Fanning, this one being on the repairs; cost of repairs, Oct. 19, 1893 (note, p. 305); also brief abstract of annual report of J. W. Oliphant, Secretary Board Public Works, Jan. 25, 1894, and note stating a supposed leak at the site of the power house, had proved to be only a spring, not connected with reservoir, June 14, 1894 (p. 485).

Description of dam, partial failure and repairs, to date, by Frank E. Snyder, Aug. 29, 1894.*

Silting Up of Lake McDonald (the reservoir formed by the dam) and leaks in the dam, by Prof. T. U. Taylor, Feb. 22, 1900.*

Is the Trouble at the Austin Dam an Argument Against Municipal Ownership? A letter from R. S. Hale, maintaining that it is, with editorial comment, and with a report by Roger W. Babson, Engineer to the bondholders, March 29, 1900.

by Mr. Frizell, just mentioned, led to a controversy over the engineering ethics of the case, and also to a considerable discussion on the forms taken by thick sheets of water flowing over dams with flat and rounded crests. A full list of references to these two lines of discussion is given in the preceding footnote. One point which has been overlooked in considering the ethics of the case was the fact that Mr. Geyelin was called in before Mr. Fanning, and that there appears to have been a pretty close agreement in their views, on the subjects considered by each, as may be seen from the foregoing.

About the time the dam was completed, a break occurred in the ground above, under and below the masonry bulkhead, about an acre in extent, resulting in a break in the masonry at this point, as shown in Fig. 4. An account of this break was given in our issue of Feb. 22, 1900, together with the repairs made, the extension of the masonry to the east, and recent leaks in this quarter. Numerous other references to the break are given in the footnote, already mentioned. The break was due to a fault in the limestone formation at this point, the masonry resting on about 20 ft. of rock, beneath which was a soft layer 4 to 8 ft. thick, which washed out after the lake filled. The ruined masonry was rebuilt, and a concrete wall 8 and 5 ft. wide, was carried 57 ft. below the crest of the dam and 112 ft. into the east bank.* At R 8, Fig. 4, a tunnel was driven beneath the bulkhead, in the soft material, and filled with concrete, all as described more fully in our issues of Aug. 2, 1894, and Feb. 22, 1900.

Before the repairs were completed, or in July, 1893, Mr. E. W. Groves, the engineer in charge of the dam after Mr. Frizell's resignation, also resigned. He gave as one of his reasons for this action, constant interference in the engineering work by Mr. John McDonald, Mayor of Austin, and President of the Board of Public Works. Mr. McDonald, on the other hand, asserted that Mr. Groves "has neither the skill nor the executive ability to conduct the work properly," and that he is satisfied that Mr. Groves "will not be guided by advice, and will not listen to reason." He was succeeded by Mr. Gorham P. Low, M. Am. Soc. C. E., who continued in charge until his death, about six months later. Mr. Groves' resignation has been mentioned because it served to bring out some very decided statements regarding the interference of Mr. McDonald with the prosecution of the work, and because it seems to substantiate claims to the effect that he and other members of the Board of Public Works really initiated controversies which afterwards caused so much trouble among various engineers. In our issue of June 29, 1893, in an account of the failure of the dam published in one of the Austin papers, there appeared what purported to be official communications from the secretary of the Board of Public Works to Mr. Jas. Waterson, the contractor for the power house, and to Mr. N. Werenskold, engineer, instructing both "to follow instructions of the Mayor with reference to excavation and the building of the power house, foundation, abutment wall and other work."

We expect to give a full description of the failure in our following issue. We have prefaced it by this somewhat lengthy account (but yet a mere outline) of what has preceded in view of the magnitude of both the structure and its failure, and the many engineering, financial and municipal interests affected thereby. What these are may be partly appreciated by this review, and may be more fully considered by consulting the various articles to which references have been made, the last one, in particular, discussing the bearing of the preceding troubles at the dam upon the question of municipal ownership, and also upon the financial integrity of the city of Austin.

STORAGE BATTERY TRACTION on the Chicago Electric Traction Co. (formerly the Chicago & Englewood Electric Ry.) is to be abandoned in favor of the overhead trolley system. This decision has been arrived at after careful investigation, which is said to have shown a much higher percentage of cost of operation and maintenance for the storage battery system, while the addition of branch lines has made it inconvenient and expensive to supply cars which run only on the branches. These cars have to be run at intervals to the main power station, or to be charged at sub-stations, while the best economy is effected where all the work is concentrated at one power station. From an engineering point of view the storage battery system has been very successful, the results of two years' operation showing an average service of 23,000 car miles to each battery. The road was built in 1896 and put in operation in June, 1897. It was 12 miles long, with 9 miles of double track and a branch line of 2 miles in length. The power station was located about the middle of the line. In 1899, an extension six miles long was built, and a sub-station established for charging the cars on that extension. The road and its power plant were described and illustrated in our issues of Jan. 6 and Feb. 3, 1898.

A STRIKE of employees in the electric power stations of the Chicago City Ry. occurred April 6, and it is rumored that this will spread to the cable power stations. The grievances which lead to the strike are the substitution of two shifts of 12 hours each for three shifts of eight hours each, and the discharge of old employees to make room for men from St. Louis. Mr. McCullough, the General Manager, and Mr. Wilson, the Engineer, were formerly connected with the St. Louis street railway company. The two electric power stations are at Oakley Ave. and 49th St., and Wabash Ave. and 52d St., and the men went out at 3 p. m., but afterwards returned to the Oakley St. station until 6 p. m. Traffic was stopped for about three hours, but during the evening the company secured a complete force of new men.

THE HEAVY-TRAFFIC MOTOR VEHICLE TRIALS AT LIVERPOOL, ENGLAND.

While these trials of last July and August have been given in part in this journal, the official report of the judges, for the Liverpool Self-Propelling Traffic Association, has appeared, and from it some brief abstracts are made.

The first set of trials, of May, 1898, made it clear that considerable improvement in construction was essential to any wide use of motor vehicles for heavy traffic, and a second trial was ordered for July and August, 1899. The points to be considered by the judges were—Cost, or economy of working, including attendants; control in stopping, starting, changing speed, steering, etc.; working conditions, including adherence on greasy road surface, noise, smell or other nuisance, efficiency of brakes, number of mechanical operations required of driver, etc.; construction. The vehicles were to be propelled either by steam, oil or electricity; and the two routes to be traversed were 35.9 and 35.6 miles long, respectively, with paved, partially paved and chiefly macadam surfaces. The minimum load was fixed at 2 tons; which resulted in steam alone being represented in the trial. The judges say, however, that two oil-motors for heavy traffic were being built for this trial, but were not completed in time. The great weight of the storage batteries debarred electricity, where the mileage was as much as 40 per day, and the load fairly heavy. The following entries were received:

Class A.—Minimum load, 2 tons; maximum tare, 2 tons; minimum level, platform area, 50 sq. ft.

No. III. T. Coulthard & Co., Cooper Road, Preston.

No. XI. The Automobile Assoc., Ltd., London.

No. VII. The Thornton Motor Co., Hulme, Manchester.

Class B.—Minimum load, 3½ tons; maximum tare, 3 tons; minimum level platform area, 65 sq. ft.

No. IX. Bayleys, Ltd., Newington Causeway, London.

No. X. Simpson & Bodman, Cornbrook, Manchester.

No. VI. The Clarkson & Capel Synd., Deverell St., London.

No. VIII. The Graham Equipment Co., Boston, Mass., U. S. A.

No. V. The Lancashire Steam Motor Co., Leyland, Preston.

No. I. The Steam Carriage & Wagon Co., Chiswick.

Class C.—Minimum load, 5 tons; maximum tare, 3 tons; minimum level platform area, 80 sq. ft.

No. IV. C. & A. Musker, Bootle, Liverpool.

Class D.—Minimum load, 6½ tons; maximum tare, 4 tons; minimum level platform area, 110 sq. ft.

No. II. The Steam Carriage & Wagon Co., Chiswick.

Of the above only six vehicles were actually entered for trial; or Nos. I., II., III., V., VI. and IX. No. III. was placed outside the above classification; as its tare was too great for Class A, and its level platform area too low for Class B.

No. I. was 16 ft. long by 6½ ft. extreme width, with a steel frame and wooden wheels of the military type. The front wheels were 2 ft. 9 ins. diameter, and the driving-wheels, 3 ft. 3 ins., with 5¼-in. tires on all. The boiler was of the well-known Thornycroft, curved water-tube type; with 82 sq. ft. heating surface, 2.4 sq. ft. grate area and a test pressure of 250 lbs. per sq. in. The engine was of the horizontal, compound, reversing type, with 4 and 7-in. cylinders, and 5-in. stroke, entirely enclosed in a dust-proof and oil-tight casing. The transmission was by pinions, and thus chainless. Vehicle No. II., built by the same company, was similar to No. I.; except that the boiler had straight tubes, the engine is lighter and the working pressure in the boiler is 25 lbs. higher.

The 2-ton steam lorry, No. III., was fitted with a Leyland fire-tube boiler, with tubes of less diameter at the top than at the bottom. The heating surface was 77 sq. ft., and the working pressure was 200 to 225 lbs. per sq. in., with a test-pressure of 450 lbs.; liquid fuel was used with a "Leyland" burner. The engine was of the triple expansion, vertical, uni-direction type, with 2¾, 4⅛ and 6-in. cylinders and 5-in. stroke, and was to develop 14 B. HP. at 500 revolutions per minute. Power was transmitted to the driving wheels by means of spur-gearing connecting the engine shaft and first motion shaft; friction clutches being employed to put the gears into action.

The 4-ton Leyland steam lorry, No. V., was fitted with a similar Leyland boiler and liquid fuel burner, and engines described in the last year's report. The 4-ton steam lorry, No. IV., had a boiler of the fire-engine type, with small inclined cross-tubes of steel; 66 sq. ft. heating surface, supplemented by 14 sq. ft. of copper feed-coil located in the up-take. The working pressure was 200 lbs., and the test pressure 350 lbs. to the sq. in. Liquid fuel was used to generate steam supplied to burner of the true Bunsen type. The engine was a vertical, compound, reversing, with 2¾ and 6-in. cylinders and 4-in. stroke, developing 14 B. HP. at 600 revolutions. The engine shaft carried a two-speed gear; with the higher speed put into engagement by an expanding clutch, and a Renald chain used to transmit power to the second motion.

The 3½-ton steam lorry, No. IX., had a De Dion boiler, with 70 sq. ft. heating surface and a working pressure of 200 lbs.; it is centrally-fired with coke. The "Straker" engine was of the compound, vertical, inverted, reversing type, with 4 and 7-in. cylinders and 5-in. stroke, developing 22 B. HP. at 500 revolutions. Power was transmitted by bevel and spur gearing. It should be said that in all these vehicles the moving parts are enclosed in dust and oil-proof casings.

In the trials for long distance, hill-climbing, manœuvering, etc., all of these vehicles did well, and stoppages due to minor accidents were much less frequent than in the trial of 1898. The jury awarded prizes for best performance to vehicles Nos. I., V. and II.; and diplomas of merit were given to No. III. for excellence of engines and general design, and to No. VI. for excellence of burner, automatic float-feed gear and condenser.

On cost of working the jury reported as follows: The estimated costs per net ton-mile are given for three sets of working conditions: A, B and C, with distances traversed in 10 working hours per day of 35, 50 and 25 miles. Conditions A and B correspond to a service between points where a full load can be secured in both directions; while C is applicable to any condition where only 50% of the possible number of ton-miles is obtainable. The cost per passenger-mile for omnibus service may be taken at 1-14th of these per net ton-mile, as given in the table. It should also be said that vehicles Nos. I., III., V. and VI. admit of sufficient control by one attendant; No. II. requires a

*A press report at the time of the break stated that the dam (or bulkhead) was not carried so far into the east bank, by 50 ft., as recommended by Mr. Frizell.

Vehicle.	Prime cost.	Load carried, tons.	Commercial speed, miles per hr.	Ton-miles of load per annum at 260 working days.	Consumption: Fuel: Per vehicle mile.	Consumption: Fuel: Per ton-mile of load.	Consumption: Water: Per vehicle mile, galls.	Consumption: Water: Per t'n-mile of load, galls.	Cost of: Motive power per ton-mile of load.	Cost of: Attendants per ton-mile of load.
No. I.	£590	3.73	5.31	48,490	8.88*	2.38*	7.15	1.88	0.27d.	0.44d.
No. II.	£640	6.65	5.67	86,450	12.46*	1.87*	9.81	1.33	0.22d.	0.36d.
No. III.	£400	2.32	4.78	30,160	.....	.....	.....	.....	.....	.....
No. V.	£450	4.44	5.02	57,720	0.539†	0.121†	4.00	0.91	0.62d.‡	0.38d.
No. VI.	£450	3.35	4.94	43,550	0.724†	0.216†	2.13	0.64	0.09d.	0.52d.
No. IX.	£600	3.67	4.93	47,710	6.76‡	1.84‡	4.65	1.27	0.13d.	0.65d.

* = lbs. of coal. † = galls. of oil. ‡ = lbs of coke. ‡Last year's cost was 0.53d. with kerosene at 4d. per gallon; with kerosene at 5d.—the present cost—the figure for 1898, would have been 0.66d.

second attendant for the trailer, according to law; and No. IX. required a stoker. No. III. was withdrawn, owing to an accident.

The accompanying table gives the summary of factors effecting the costs per net ton-mile:

Without going into the detail of the number of tables presented, the estimated annual expenditure for each type of vehicle, under the conditions of Classes A, B and C, as before noted, may be condensed with the following constant factors understood: Interest at 5%, depreciation at 15% per annum, kerosene oil at 5d. per gallon, water at 1d. per 1,000 gallons, gas-coke at 11s. 6d. per ton, South Wales coal at 20s. per ton, driver at 35s. per week, attendant at 15s. per week, rent, taxes, rates and insurance included. Under these conditions of prices the record would stand as follows:

	Estimated annual expenditure. £ s. d.	Cost per net ton-mile.	At miles per hour.
Condition A.—35 miles per day; laden.			
No. I.	362 4 7	2.56d.	5.31
No. II.	452 9 8	1.79d.	5.67
No. V.	408 12 2	2.43d.	5.02
No. VI.	443 9 7	3.49d.	4.94
No. IX.	397 3 2	2.85d.	4.93
Condition B.—50 miles per day; laden.			
No. I.	400 11 10	1.98d.	5.31
No. II.	502 11 9	1.40d.	5.67
No. V.	480 3 7	2.00d.	5.02
No. VI.	529 14 4	2.92d.	4.94
No. IX.	431 16 8	2.17d.	4.93
Condition C.—25 miles laden, and 25 miles light, per day.			
No. I.	391 4 6	3.87d.	5.31
No. II.	489 9 6	2.72d.	5.67
No. V.	455 8 3	3.79d.	5.02
No. VI.	496 16 2	5.48d.	4.94
No. IX.	427 11 5	4.30d.	4.93

The jury, in its conclusions, says that the vehicles tested in 1899 may be regarded as having arrived at such degrees of mechanical excellence and efficiency, that their use in practical trade operations will be attended with success and economy, as compared with horse traction. These vehicles are suitable for trade purposes in Liverpool and neighborheed, as on paved streets the speed is double that of horses with equal loads, and the motor-wagon overcomes the present difficulty of ascending and descending hills. They will compete advantageously with horses for the transport of loads of 4 to 6½ tons over distances up to 40 miles; for this distance a working day of 12 hours should be sufficient for collection, transport and delivery.

It seems necessary at present, over roads such as were traversed in the trials, and at speeds of 5 to 6 miles per hour, to allow 15% on the first cost for maintenance, with the motor-wagons of the admirable designs submitted; for wagons not so well designed or made this figure may rise to 30%. The general control, starting, steering and stopping of these motor-wagons, when working on the road, and with other traffic, was superior to the best types of horse-drawn vehicres; and they are capable of going anywhere that horse-drawn vehicles are ordinarily required to go. In the tests at Everton they stopped and started on a grade of 1 in 9, on both the up and down trips.

The jury noted the importance of placing as much of the weight as possible on the driving axle, and the necessity of reducing in number and conveniently disposing the operating gear. They decide that there should be at least two speed gears, or an equivalent reserve of power; coke, or solid fuel, is noted as more economical than liquid fuel; and the condensers must be of high efficiency to meet conditions of only finding water at 15 miles intervals. The speed of five miles per hour, as permitted by law, seems a suitable limit for heavy traffic; as higher speeds tend to the deterioriation of frame and wheels through vibration and shock. Four tons carried on three tons of dead weight at five miles per hour is the maximum satisfactory performance to this time; but a load of 7 tons can be carried if a single trailer be used. The chief mechanical cause of slow progress lies in the wheels and tires, submitted to a concentration of heavy load. The judges strongly hold that the requirements of trade in large manufacturing and distributing centers cannot be met with a load limit of 4 tons; to satisfy existing conditions 6 and 10 tons must be carried on one platform; and here there must first be a change in the Locomotive on Highways Act of 1896, fixing a limit of 3 tons tare, or dead weight of vehicle. The judges say that with a permissible 4-ton tare, we could shortly have self-contained motor-wagons capable of carrying 6 to 8 tons at 4 to 5 miles per hour, and 10 to 12 tons at reduced speeds.

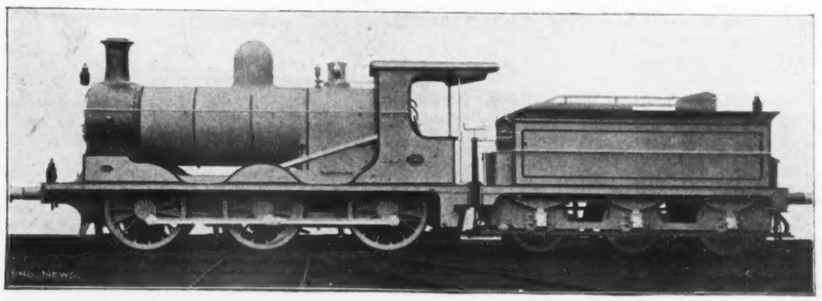


FIG. 1.—FREIGHT LOCOMOTIVE; EAST INDIAN RY.
Vulcan Foundry (England), Builders.

FREIGHT LOCOMOTIVE; EAST INDIAN RY.

The railways of India, aggregating about 26,000 miles, are among the best customers of the English locomotive building firms, and standard English practice (with some modifications) is pretty generally followed in the construction of engines for these railways. During the past year, however, at least two American firms have built and shipped locomotives for railways in India, and the English builders will probably have to meet a closer competition in future. The accompanying illustration, Fig. 1, represents a freight engine of English design for the East Indian Ry., and 56 of these engines (with 40 tenders) were built in 1899 by the Vulcan Foundry, of Newton-le-Willows, England. For photographs and information respecting these engines we are indebted to Mr. Walter Norman, who was until recently Manager of the works, and is now Manager of the new locomotive works of the reorganized Stephenson Engineering Co.

The engine has six wheels, all coupled, and the driving springs are quite independent of each other, no equalizing levers being used. The leading and main driving axles have a pair of coiled springs under each box, while the trailing axle has semi-elliptic plate springs under the boxes. Deep plate frames are used, slotted for the boxes, and cut away between the axles in order to reduce the weight. The cylinders are inside the frames, under the smokebox, with the valve chests between them. Each crosshead is formed in one piece with the piston rod, and has cast-iron slideblocks 1 ft. 1½ ins. long, running in two grooved guide bars, shown in section by the sketch Fig. 2. The connecting and coupling rods are of I-section, and the latter have solid ends, the crank pins for these rods being fitted in heavy cheeks on the hubs of the wheels. The Stephenson expansion link valve gear is used, supported at the top, and is operated by a screw reversing gear, the hand wheel of which may be seen in the cab.

The boiler is flush from end to end, and the barrel is of telescopic construction, with a short smokebox. The Ramsbottom duplex safety valves and the whistle fittings are over the firebox, while the large and high dome is just forward of the firebox. The sandboxes are formed in the splashers or covers of the leading wheels, and their pipes are fitted with a sand-jet device. The firebox is of copper, with a tube sheet ⅞-in. thick at the tubes, and 9-16-in. below the tubes. The tubes are of brass, fitted with ferules 1 13-16 ins. diameter.

The tender is of the standard English pattern, on six wheels of large diameter, the axles having outside bearings in deep plate frames, and having a semi-elliptic plate spring over each axle box. The front of the coal space is closed and fitted with doors, and a railing and back board allow of the coal being piled up. On each side of the tender deck is a locker, and there is the usual hand-brake. Spring buffers, screw couplings, rail guards or "knives," and small marker lamps form a part of the equipment of the engine and tender.

The East Indian Ry. is built to the Indian standard gage of 5 ft. 6 ins., and its system aggregates about 1,715 miles, with an equipment of about 700 locomotives. The dimensions of the engines above described are given below in our standard form:

Freight Locomotive; East Indian Ry.

Running Gear:	
Driving wheels (6)	5 ft. 1 in.
Tender wheels (6)	3 ft. 10½ ins.
Journals, driving axles, 8x9 ins.; tender axles	5x9 "
Wheelbase: Driving and total	15 ft.
Tender	12 "
Engine and tender	36 ft. 2½ ins.
Wheels having blind tires	None.
Weight in Working Order:	
On leading wheels	32,480 lbs.
On driving wheels	33,376 "
On trailing wheels	31,360 "
Engine, total	97,216 "
Tender, empty..40,824 lbs.; loaded	81,984 "
Water in boiler (at half glass)	8,288 "

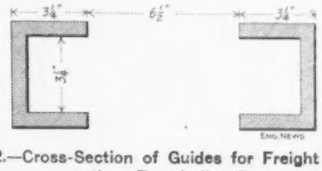


Fig. 2.—Cross-Section of Guides for Freight Locomotive; East Indian Ry.

Cylinders: No.	Two.
Diameter and stroke	18x26 ins.
Distance c. to c.	2 ft. 6½ "
Distance from c. of cyl. to valve face	1 " 0 "
Piston rod, diameter	3 "
Form of guides	Two channeled bars.
Connecting rod, length between centers	6 ft. 4 ins.
Side rod	Solid ends.
Valve Gear: Type	Stephenson link.
Ports, steam...1⅝x16 ins.; Ports, exhaust...3½x16 ins.	
Slide valves, maximum travel	3 27/32 "
" lap ...⅞-in.; lead	5/32-in.
Boiler: Type	Straight top.
Diameter barrel, inside smallest ring	4 ft. 6 13/16 ins.
Barrel plate	17/32-in.; smokebox tube plate ⅞-in.
Height from rail to center line	7 ft. 9½ ins.
Length of smokebox	2 "10½ "
Working steam pressure	160 lbs.
Firebox: (Copper)	Flat top, with crown bars.
Length, inside 5 ft. 7 11/16 ins.; width, inside 4 ft. 2 9/16 ins.	
Depth at front....6 ft. 0¼" ; depth at back, 4 ft. 4½ "	
Thickness, side and back plates	5/16-in.
Thickness, crown plate, 9/16-in.; tube plate ...⅝ to 9/16-in.	
Crown stays	Crown bars.
Stay bolts (copper)..No. 620; diam...1 in.; pitch..4 ins.	
Water spaces, width at bottom, 2½ ins.; at top, ..4 "	

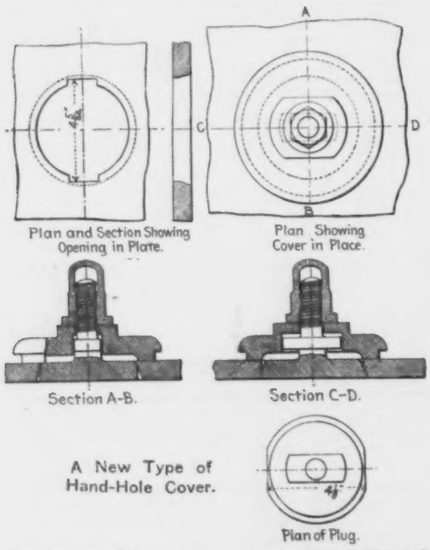
Tubes: (Brass), No.	236
Thickness..No. 11, 12 & 13 W.G.; pitch.	2½ ins.
Diameter, outside	1¾"
Length over tube plates	10 ft. 7⅜"
T'l area tube opngs (inside ferules, $1^{13}/_{16}$ ins.)	1,081 sq. ft.
Heating Surface and Grate Area:	
Heating surface, tubes (interior area)	1,131.7 sq. ft.
" " firebox	109.0 "
" " total	1,240.7 "
Grate area	24.0 "
Miscellaneous:	
Exhaust nozzle, diameter	4¾ ins.
Smokestack, smallest diameter	1 ft. 4 "
Smokestack, height of top above rail	13 " 5¾"
Capacity of tender tank	3,000 gallons.
Capacity of coal space (225 cu. ft.)	5 tons.
Brake fittings	Steam brake on engine and tender.

Engines of the same type as the above, that is, having six driving wheels and no truck, have been built by the Baldwin Locomotive Works for the Eastern Bengal State Railways. These lines are also of 5 ft. 6 ins. gage, aggregating 905 miles in length, with 104 locomotives. The boiler has an extension smokebox, and a dome on the middle of the barrel, while the sandboxes are placed under the running board, in front of the middle (main) pair of driving wheels. The cylinders are outside, with two-bar guides, alligator crossheads, and flat side rods. A six-wheel tender is used, and the engine and tender are fitted with rail "knives" or guards, spring buffers, small marker lamps, etc., in accordance with English practice, to conform to the requirements of the road. The firebox is of ½-in. copper plates, except that the tube plates are ¾ and ½-in. thick. The cab is of the American pattern. The principal dimensions of these engines are as follows:

Driving wheels	5 ft. 1½ ins.
Tender wheels	3 " 7½ "
Journals of driving axles	8 × 12½ "
Wheelbase, engine	15 ft. 0 "
" " and tender	39 " 4 "
Weight of engine	101,550 lbs.
" tender, empty, 31,000 lbs.; loaded,	66,450 "
Cylinders	18 × 26 ins.
Boiler, diameter	4 ft. 6 "
" pressure	160 lbs.
Firebox, length, 6 ft. 8 ins.; width	3 ft. 6 ins.
" depth at front, 5 ft. 9 ins.; at back	4 " 5 "
Tubes, 221; diam., 1⅝ ins.; length	11 ft. 6¼ "
Heating surface, tubes	1,153.8 sq. ft.
" " firebox	116.2 " "
" " total	1,270.0 " "
Grate area	23.2 " "
Capacity of tank	3,000 gallons

A NEW TYPE OF HAND-HOLE COVERS.

The accompanying drawings, reproduced from "Engineering" (London), show an ingenious cover for mud-holes and man-holes in boilers or other vessels intended to hold fluids under pressure. The hole in the boiler-plate is reamed out conical, forming a seat which the inner cover, or plug, is turned to fit. In order that this plug may be passed through the hole, part of its outer rim on opposite sides is planed off, and the inner rim of the seat is likewise cut away in two places. Thus



the plug may be inserted, and by turning it through 90° the chamfered portions of the plug and seat no longer coincide and the joint is perfectly tight. A threaded bolt projects outward from the center of the plug. The outer cover-plate, which is pierced in the middle, is slipped over this and held in place by a nut on the bolt. Near the base of the bolt is a cross-bar. When the nut outside the outer cover-plate has been sufficiently loosened a forked tool, similar to a clothes-pin, is slipped in behind this cross-bar, thus preventing the plug from falling into the boiler when the outer cover is removed. The device above described is the invention of Mr. J. C. R. Okes, of Ormond House, 63 Queen Victoria St., London.

BOOK REVIEWS.

L'ECHAPPEMENT DANS LES MACHINES A VAPEUR.—Par G. Leloutre, Ingenieur Civil Encyclopadie Scientinque des Aide-Memoire. Paris: Gauthier-Villars. Paper; 7⅝ × 4⅝ ins.; pp. 156; 75 cts.; boards, 90 cts.

With much detail of reasoning and formula the author of this work presents facts and theories concerning the condition of steam during the cycle of operations in the engine cylinder, and he then establishes for some fixed point in the stroke of the piston the proportion of water contained in this vapor. He contends that this contained water has a very bad effect upon the economic working of the engine, and to prove this he gives a long list of the results of experiments which he has conducted.

K. K., THE COMPLETE CODE FOR THE USE OF AGENTS, BANKERS, BROKERS, SHIPPERS, ETC., AND THE TELEGRAPHING PUBLIC.—By G. Sutherland. London: Eyre & Spottiswoode; New York: E. & J. B. Young & Co. Leather; 8⅝ × 5¼ ins.; pp. 567. $10.

This cipher code for the transmission of secret messages is claimed to be the most complete in use, and it certainly is simple and easily employed. One code word stands for a sentence, or part of a sentence; and as the code words are alphabetically arranged, the real message sent is quickly ascertained. But, as the author explains, each sender and receiver may add or deduct from the code number some number previously agreed upon and send a message that cannot be read even by one possessing the K. K. code.

VERTICAL GRADIENTS OF TEMPERATURE, HUMIDITY AND WIND DIRECTION.—A preliminary report on the Kite Observations of 1898. By H. C. Frankenfield, Forecast Official; Willis L. Moore, Chief of Weather Bureau, Washington. Cloth; 11¾ × 9⅛ ins.; pp. 71; illustrated.

In this monograph Prof. C. F. Marvin first describes the construction and operation of the kite employed and the design of the meteorograph and aerial apparatus used in making the observations here discussed. Between April and November, 1898, kite ascensions were made at 17 stations, distributed over the United States, whenever the weather permitted. The summard of the observations gives the elevation of the station above sea level, the number of ascensions at each place and the number of observations at elevations ranging from 1,000 to 8,000 ft. above the sea. As determined from 1,217 ascensions and 3,838 observations, the mean diminution of temperature with increase of altitude, was 5° for each 1,000 ft., or 0.4° less than the true adiabatic rate. The relative humidity, at and above the surface of the earth, averaged 60% at the surface and 58% at 8,000 ft. elevation. The report gives the details from which these ratios are deduced.

THE PRINCIPLES OF ARCHITECTURAL COMPOSITION.—By John Beverly Robinson. The Architectural Record Co., New York. Cloth; 6½ × 9¾ ins.; pp. 135; 301 illustrations. $2.50.

In introducing his subject the author remarks that while it will, perhaps, never be possible to reduce the art of delineating and arranging pleasing forms to an exact science, it is possible to analyze and classify these operations in such a way as to help one to make a simple and pleasing design or an intelligible criticism. With this proposition as his principal theme the author has produced a book whch should be very helpful to laymen and engineers, whatever its value may be to the professional architect. To the practicing engineer who has often to exercise artistic discrimination and architectural skill in locating, grouping and detailing his structures, such as bridge piers, abutments and approaches, and water towers, and whose taste or lack of taste in these matters is so often deservedly criticised, the book should prove a boon in many respects. It will not make of him a master in design in its most delicate discriminations, for this must always remain a matter of talent and temperament, but it will help him to see what is essentially bad in design and to know to some extent why it is so.

In the first chapter of the book the author points out the involved nature of artistic design due to the fact that nowadays architectural forms rarely seek expression except as including some useful purpose. In chapter two the two fundamental qualities of unity and grace are discussed. It is in this chapter and in the six chapters which follow that the matter which is of the greatest value to the engineer will be found. These discuss the grouping of the main masses, subordinate parts and appendages, the grouping of details, horizontal subdivision, and proportion. Almost equally important is the next to the last chapter of the book, on double composition. The remaining chapters discuss various collateral questions connected with the subjects just mentioned. A very valuable feature of the book to the uninitiated is the list of illustrations of both good and bad design as exemplified by actual structures, with the explanatory captions which accompany and elucidate the drawings. The publisher's work on the book is generally good.

WATER SUPPLY AND IRRIGATION PAPERS OF THE U. S. GEOLOGICAL SURVEY. No. 33. Storage of Water on Gila River, Ariz. By Joseph Barlow Lippincott, Washington, D. C. Paper; 9 × 6 ins.; pp. 98; maps, plans and views.

This bulletin details the results of surveys for reservoirs on the Gila River; started by Mr. A. P. Davis in 1895; completed by Mr. J. B. Lippincott, and the conclusions verified by Mr. James D. Schuyler, M. Am. Soc. C. E. The purpose of the survey was to provide means of storing water for irrigation purposes on the Gila River Indian Reservation, of 357,120 acres of land, and for the adjacent lands. The Pima, Maricopa and Papagos Indians living upon this reservation were industrious, prosperous and independent of outside aid until the settlement of the Gila Valley above the reservation partly cut off their water supply, and practically destroyed their agriculture, always dependent upon artificial irrigation. The report covers the details of the investigation made and gives the plans and estimates for the dams proposed at the Buttes, Riverside and at San Carlos. At the first place a combination rock-fill and concrete masonry dam is proposed, at an estimated cost of $2,643,327, or $15.19 per acre-foot of water stored; the total storage being 174,040 acre-feet. This dam would have a base of 312 ft. at the bed of the river; and the foundation walls of concrete, 40 ft. thick, would descend 122 ft. below this bed at the deepest point. The dam proper would be largely rock-fill, 170 ft. high above the river-bed, and faced on the upstream slope with 5 ft. of concrete and imbedded steel plates. The report illustrates the inlet tower, drainage tunnel, spillway, etc., and gives interesting details of the investigation of the site by means of the diamond drill; quarry tests, etc.

The Riverside reservoir would be on the Gila River, in Final Co., Ariz., and the dam would be located in a granite canyon with a bed 350 ft. wide. The proposed dam would be a concrete overflow weir, as the location does not admit of side spillways. A dam 153 ft. high would impound 221,134 acre-feet of water, at a cost of $1,992,605, or $9.01 per acre-foot. The masonry would be half large rock and half concrete.

The San Carlos reservoir site is located on the Gila River, in Gila Co., Ariz., where the San Carlos joins this river. The dam proposed would have a vertical back; 186.3 ft. base; 78 ft. below the river bed, and be 142 ft. high above the bed; the top width would be 16 ft., with the water passing over the dam. The estimated cost is $1,038,926 for 241,396 acre-feet stored, or $4.30 per acre-foot. Surveys and estimates were also made for dams at Guthrie and Queen Creek.

In connection with the proposed use of large quantities of concrete in these dams, and the remoteness of the dams from lines of transportation, Mr. Lippincott instructed Mr. Edward Duryee to investigate sand-cement, as a means of reducing the volume of cement required. It was considered that Portland cement was essential in the construction of dams exposed to severe and sudden strains due to floods, and the experiments were conducted with this cement. The sand used was so fine that only 5% residue was left on a screen of 40,000 meshes to the sq. in.; and the rock ground was pearlite from the Buttes dam site, and quartzite from San Carlos. The Portland cement was made at Colton, Cal., that being the nearest place to the reservoirs. In making the sand-cement, equal weights of pearlite and Portland cement were ground together in a mortar until the mixture passed through a screen of 40,000 meshes to the sq. in.; and the San Carlos quartzite and Portland cement were treated in a similar manner. The coarse sand used in making mortar with the sand-cement —and with the pure Portland-Colton cement, in making comparative tests—was of the ordinary degree of fineness; all residue on the 20-mesh screen being rejected, and all left on the 30-mesh screen was retained.

As a general result of the tests it was found that sand-cement and sand, representing a proportion of 1 Colton-Portland cement to 5 sand, in 28 days, showed a strength of 300 to 345 lbs.; as compared with 385 lbs. for 1 pure Colton-Portland cement to 2 ordinary sand. It was found that about the same value could be obtained in the following concrete mixtures: (1) Portland cement 1, sand 3, broken stone 7 parts; (2) Sand-cement 1, sand 2, broken stone 6 parts. The first of these mixtures cost $5.72 per cu. yd. of concrete, and the second $4.08 per cu. yd.; but out of the saving of $1.64 per cu. yd. must be deducted the cost of the grinding plant and its operation. The estimated cost of the Colton-Portland cement, delivered at the dam site, is $8 per barrel of 375 lbs., or 2.12 cts. per lb. The cost of the sand-cement made from this Portland cement at the dam is given as follows?

One-half barrel Portland cement	$4.00
One-half barrel crushed quartzite	.18
Grinding the above in a mill	.20
Sand-cement patent royalty	.05
Total cost of one barrel (375 lbs.)	$4.43

The cost of the mill is not included in the above, but with this item out, the cost of the sand-cement is 1.2 cts. per lb. The approximate cost of a crushing and grinding plant, with a capacity of 240 barrels in 24 hours, is set down at $10,000.